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TACTICAL NET RADIOS:

NONDEVELOPMENTAL-ITEM OPERATIONAL ASSESSMENT

(MANPRINT EVALUATION)

Volume I

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FOREWORD

The United States Army Research Institute for the Behavioral and Social Sciences (ARI), through its Systems Research Laboratory, works to increase the combat readiness and effectiveness of Army personnel systems and units through manpower, personnel, training, and human performance research in the development, acquisition, and operational performance of units and systems.

The MANPRINT assessment reported here (part of ARI Fort Hood Field Unit's "Manpower, Personnel, and Training Considerations in User Testing" program) was performed in conjunction with the Nondevelopmental-Item Operational Assessment conducted by the U.S. Test and Evaluation Agency (OTEA) during August - October 1986 (pursuant to "Letter of Agreement between the U.S. Army Research Institute for the Behavioral & Social Sciences and U.S. Army Operational Test & Evaluation Agency," June 1983). The report provides trainability and operability indices and detailed human factors findings for each of ten nondevelopmental tactical net radio systems that the U.S Army wished to consider as interim or permanent replacements for the current family of VRC-12 series radios.

Sections of the report were provided to OTEA throughout 1987 for redistribution to the Communications and Electronics Command, which, in turn, was responsible for disbursing relevant results sections to the system vendors who submitted systems for evaluation during the assessment.

Owing to its length this report is provided in two volumes. Volume I contains the body of the report and Annex A (copies of the data collection instruments). Volume II consists solely of Annex B, the self-contained results packages provided for the vendors.

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TACTICAL NET RADIOS: NONDEVELOPMENTAL-ITEM OPERATIONAL ASSESSMENT (MANPRINT EVALUATION)

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TACTICAL NET RADIOS: NONDEVELOPMENTAL-ITEM OPERATIONAL ASSESSMENT (MANPRINT EVALUATION)

INTRODUCTION

The proficiency with which one can use a piece of equipment is dependent upon both operator training and operator-machine interface characteristics. Major concerns related to training requirements and the conduct of training include factors such as the nature of the trainee, the complexity of the equipment, and the desired performance proficiency level. Variables that influence the outcome of training (i.e., performance) include the amount of training time, instructional methods, and the type and quality of training aids, to mention but a few. In an operational assessment of equipment and operator performance, such as that with which this report is concerned, in which the equipment evaluated is essentially new to the soldier and a major interest is vested in performance proficiency, these training and operator-interface concerns are of great importance.

This document describes the MANPRINT evaluation of 10 tactical net radios by the U.S. Army Research Institute, Fort Hood Field Unit. The research was performed at Fort Riley, Kansas, in conjunction with the Nondevelopmental-Item (NDI) Tactical Net Radio Operational Assessment conducted by the U.S. Operational Test and Evaluation Agency (OTEA) during the period August through October, 1986.

System Description

Nondevelopmental items are those that are readily available through normal contract and procurement channels and do not therefore have to go through the typically arduous development and acquisition process necessary for undeveloped materiel items. Ten vendors submitted the following 10 tactical net radio systems for evaluation during this assessment:

1.	Ericsson	(Sweden)	StarCom
2.	Harris	(USA)	PRC-117, VRC-94
3.	ITT	(USA)	SINCGARS
4.	Marconi	(United Kingdom)	Scimitar-V
5.	Racal	(United Kingdom)	Jaguar-V BCC-66HE, VRQ-31HE/HG
6.	Rockwell International	(USA)	MP-83
9.	Standard Electrik Lorenz	(West Germany)	SEM-70, -80,- 90
5.	Tadiran	(Israel)	PRC-80, VRC-8000
8.	Thomson-CSF	(France)	TRC-577, -950
10.	Transworld Communications	(USA)	PRC-1077

To qualify for participation, the vendor's radio had to possess several technical characteristics: (a) backpack and vehicular configurations; (b) 25 kHz channel spacing, from 30 to 88 MHz; (c) compatibility (interoperability)

with the current AN/VRC-12 family of radios in single-channel mode; (d) 16 kBits/sec digital data transmission capability; (e) compatibility with VINSON KY-57 communications security equipment; (f) a nominal communication range of 35 km in the high-power vehicular configuration; (g) a 28-volt vehicular power supply; (h) at least a four-channel frequency preset capability, (i) retransmission capability; and (j) operability in worldwide tactical military environments. Of the 10 radios evaluated, 8 were frequency-hopping systems, one of which was the ITT Corporation's Single-Channel Ground/Airborne Radio System (SINCGARS), which was used as a baseline of comparison for assessing the other radio systems.

Some the characteristics that differed from system to system were frequency-hopping capability and method, power outputs (particularly at low and medium settings), display characteristics, number of channel presets, front panel configurations, and operational procedures.

Purpose and Scope of the Evaluation

The NDI assessment was conducted to assess the potential of NDI radios as short-term replacements for the rapidly aging radios currently in the U.S. Army's inventory and as candidates for possible replacement of the SINCGARS frequency-hopping radio, whose development was lagging behind schedule.

The affiliated MANPRINT effort was conducted to evaluate the soldier-machine interface and the trainability of each radio system. The assessments were directed at ease of operation and other human factors aspects of operation and equipment design, personnel characteristics and problems encountered by soldiers using the radio in the field, and the quality of operator manuals. Each radio was intensively examined by human factors specialists, and, for each system, an integrated list of "observations," or findings, was produced (which included an impact statement, relevant comments, and, where feasible, suggested improvements or solutions). Trainability and Ease of Operation indices, which used the ITT radio as a baseline, were developed from the data obtained.

METHODOLOGY

MANPRINT Evaluation Team

The team consisted of two research psychologists (human factors specialists) from the US Army Research Institute (ARI), Fort Hood Field Unit. One of the team members had extensive SINCGARS evaluation experience, having directed the operational human factors evaluations of the ITT SINCGARS during the OTEA SINCGARS Maturity Operational Test at Fort Riley, Kansas (Fall, 1982) and the SINCGARS Operational Assessment at Fort Huachuca, Arizona (Fall, 1983). Both members had received previous operator training on the ITT SINCGARS.

MANPRINT Evaluation Schedule

Operator training. The MANPRINT evaluation of the 10 radios was conducted in five, overlapping, two-week cycles. These cycles took place during weeks four and five of the overall five-week cycles of the OTEA assessment. Two radios were evaluated during each cycle. During Week Four of each cycle, 24 soldiers (12 per radio) received classroom instruction on the operation of the radios. The precise amount of training varied somewhat from radio to radio, both in amount and in character, because some radios were inherently simpler to operate than others. (All instructors had been directed to provide approximately 40 hours of training. Realistically, however, is was impossible to hold the amount of training constant across radios, and some of the 40-hour block consisted of repetition and additional "hands-on" exercises for most of the radios.)

The training included a half-day pilot exercise at a motorpool during the latter part of the week. During this "mini-pilot," the radios were mounted in their vehicles and operated in actual net configurations.

The last day of the training week (typically Friday) was primarily devoted to TRADOC-controlled operator-qualification examinations, followed by administration of the Post-Training MANPRINT Evaluation Questionnaire (discussed below).

Field exercise. During Week Five of each cycle, the soldiers participated in a five-day tactical field exercise during which the SINCGARS radios were operated in normal configurations (vehicular or backpack) in a controlled manner that allowed data collection efforts to proceed with minimal interference with the on-going exercise. SINCGARS radio operation and data collection occurred from approximately 1100 to 2300 hours daily. The week typically included one or more days of adverse conditions (rain, mud, and uncomfortably cool temperatures in the 40 to 50 degrees Fahrenheit range). The soldiers returned from the field on Friday. On the following Monday they were administered the Post-Field-Exercise MANPRINT Evaluation Questionnaire and, in the case of the ITT group, a baseline retention (learning decay) test, both of which are discussed below.

MANPRINT Data Collection

Two rating questionnaires and an operation problem log were used in the MANPRINT evaluation to obtain information from the soldiers who participated in the assessment as radio operators or data collectors. These instruments (discussed under separate headings below) were designed to maximize clarity, readability, ease of response, and maintenance of interest. (References pertaining to the design of such instruments include Alerck & Settle, 1985; Babbitt & Nystrom, 1985; and Warwick & Lininger, 1975). In addition, a simulated performance test, designed to measure operator skill and knowledge retention (learning decay), was administered to the ITT operators and data collectors only. (There was insufficient time within the constraints of the overall assessment to measure retention in connection with the other vendors' products.)

Operator/data collector MANPRINT instruction. On four occasions the soldiers received instruction pertaining to the MANPRINT mission:

1. Directorate pre-training briefing: During the operator pre-briefing conducted by the assessment directorate on the Friday before Week Four, the MANPRINT team members introduced the soldiers to the MANPRINT concept and the important role they and it were to play in the overall assessment. The discussion was placed within the context of the history of SINCGARS development and the importance of the assessment (for the battlefield and in terms of dollars and cents throughout the life cycle of SINCGARS). It was stressed that much of the MANPRINT evaluation would be based upon their input.

During the pre-briefing, 6 of the 12 soldiers assigned to each radio were designated "data collectors." Although these soldiers were trained on the radios along with, and in exactly the same manner as, the other 6 soldiers, their job in the subsequent field exercise (Week Five) was to collect data for the assessment. They were not to operate the radios during the field exercise, except in the event that an operator became unavailable because of illness, injury, or an other emergency. (Despite this rule, it was not uncommon to observe data collectors "spelling" operators from time to time.)

The data collectors were required to complete on each day of Week Five a set of data collection forms which recorded information about a variety of operational events. Among the forms was the Operational Problem Log, a MANPRINT form discussed below.

2. Pre-training MANPRINT briefing: The second MANPRINT briefing took place at the beginning of Week Four during the introductory session of the operator training class. At this time the soldiers were reminded that their task was not only to learn how to operate the radio, but also to maintain a critical eye. They were informed that at the end of the training week they would be asked to evaluate from a human factors perspective their training, their operator manuals, and the radio itself (see Post-Training MANPRINT Evaluation Questionnaire, below).

3. MANPRINT data-collection instruction: Prior to the end of their training week (Week Four), all the soldiers (i.e., both data collectors and

operators) were provided instruction on using a MANPRINT data collection form that the data collectors would be required to submit throughout Week Five (see Operational Problem Log, below). (Both data collectors and operators received this instruction because, although the data collector would physically complete the form, the operator was expected to provide substantial input.) Examples of MANPRINT problems were presented and the soldiers were encouraged to report even the most trivial problem.

4. Directorate pre-field exercise briefing: Finally, at the start of Week Five, just prior to their departure from the motor pool for the field, the assessment director (a military officer in the rank of major) reminded the soldiers of their evaluation responsibilities and of the importance MANPRINT in the assessment.

Post-Training MANPRINT Evaluation Questionnaire. This rating instrument (see Annex A) was administered to the soldiers in their classrooms at the end of Week Four after all of the class had obtained passing scores on the TRADOC qualifying exams. Its purpose was to obtain systematic assessments of the operator training (29 items), the operator manuals (19 items), and the radio itself--given the soldiers' limited operating experience at that point in time (112 items). The items featured seven-point and five-point multiple-choice rating scales ranging from very positive to very negative. The items pertaining to the radio were divided into eight sections: displays, control knobs, toggle and/or button switches, keyboards (keypads), connector plugs and sockets, procedures, audio tasks, and visual tasks. The questionnaire contained a total of 160 items and provided space for optional written comments. It required about 25 minutes to complete.

Operational Problem Log. Among the data collection forms completed by the data collectors throughout Week Five was the "Operational Problem Log" (Annex A). The purpose of this form was to provide real-time documentation of MANPRINT problems as they occurred or became salient during the field exercise. The Operational Problem Log was a double-sided single page that allowed the data collectors to describe problems in detail along with the time of occurrence (if applicable) and an estimate of problem severity. Information from these forms was transcribed into a master file and was incorporated into the Post-Field-Exercise MANPRINT Evaluation Questionnaire (discussed below). It was also screened for critical comments that required follow-up for clarification or additional information.

Post-Field-Exercise MANPRINT Evaluation Questionnaire. The purpose of this 230-item rating instrument (Annex A) was to obtain systematic feedback from the soldiers after they had completed their week-long field exercise. It was administered to all operators and data collectors in their classrooms on the Monday following Week Five. ("No-shows" were rescheduled and administered the questionnaire at a later time--but as soon as possible.)

The items on this instrument came from three primary sources: (a) human factors evaluations of the radios by the two human factors specialists who composed the MANPRINT team; (b) the soldiers' comments from the field exercise (obtained from the Operational Problem Log); and (c) the Post-Training MANPRINT Evaluation Questionnaire. The items were organized into 11 sections

dealing with the following potential or actual problem areas: communication, keyboards, displays, toggle and/or button switches, control knobs, labels, indicators (audio and visual), connectors and cables, operating procedures, and backpack (manpack) configurations. The items in the first 10 sections were written in a format that required the soldiers to indicate whether or not they had experienced the problem; if so, how often; and how important they thought it was to fix the problem. The importance-of-fix was rated on a 3-point scale: 1 = "Not very important"; 2 = "Fairly important"; 3 = "Very important." Several additional questions pertained to operator manuals, training, and prior operating experience. Space was provided for optional comments. Completion time averaged about 30 minutes.

ITT SINCGARS Learning-Retention Test. A baseline retention (learning decay) test was administered to all operators and data collectors on the Monday following Week Five (20 October 1986) immediately after they had completed the Post-Field-Exercise MANPRINT Evaluation Questionnaire. The test instrument was derived from a detailed analysis of the operational procedures of the ITT radio. The items and correct responses were validated by ITT representatives. The test consisted of two sections--one that required operators to simulate the performance of operations on which they had been trained, and another in which the operators responded to queries that tested their retention of more tangential performance-related information. Most operators completed the test in about 20 minutes. This administration allowed for the establishment of a baseline skill/knowledge level against which a subsequent administration of the test (in parallel form) could be compared. The test was readministered to the ITT operators and data collectors on 14 November 1986.

Operator manuals evaluation. A rating form (see Annex A) was used by the MANPRINT evaluators to assess each vendor's operator manuals. The form provided for ratings of four to eight dimensions within each of three general areas: content, readability, and illustration. An overall rating of durability was also made. Each dimension was assigned a rating of "good," "fair," or "poor."

Common-task operator-performance evaluation. The Common-Task Operator-Performance Evaluation consisted of an attempt to compare the times required by the trainees to complete various performance tasks common to the vendors' radios. The times were recorded by the TRADOC instructors during the TRADOC qualification examinations at the end of Week Four. The specific common tasks: installing antenna, installing battery, installing handset, operating mode selection, performing built-in tests, performing communication checks, loading single-channel frequencies, loading frequencies for the frequency-hopping mode, and connecting the VINSON (KY-57) for secure-mode communication. These specific tasks were generic to four general operational functions for which total times could be computed: radio assembly, single-channel operation, frequency-hopping operation, and secure operation.

Operator demographic data. Demographic data pertaining to all operators and data collectors were obtained by the assessment directorate from the soldiers' personnel files and an inprocessing questionnaire. The demographic data of concern in the MANPRINT evaluation were: MOS, length of time in MOS, SQT score, and GT score. In addition, a question on the Post-Field-Exercise

MANPRINT Evaluation Questionnaire asked the soldiers to indicate the extent of their prior radio operating experience. The immediate purpose for collecting these data was to obtain some indication of the comparability of operators and data collectors across the 10 radios under evaluation.

RESULTS SECTION 1: NUMERICAL RESULTS AND DISCUSSION[1]

Demographic Comparisons: Operator Groups Across Vendors

The NDI operational assessment was conducted in response to an urgent Army need that allowed very little time for initial planning and coordination. Because of prior manpower commitments, unalterable training schedules, and other variables, the selection of "player" personnel (research subjects) for the assessment was probably guided as much by unit/soldier availability as by experimental design concerns. However, to minimize sampling inequities, the OTEA Test Directorate requested the supporting military units to provide "typical" soldiers who in their normal duties perform the sort of functions that would be required of them during the NDI assessment, i.e., operating tactical vehicular and backpack radios. The directorate then attempted to distribute the available soldiers within each cycle in a way that the grade structure in the two radio groups within a cycle would be similar. The opportunity to form matched groups across the 10 vendors was, however, simply not available; and it was not possible to control the distribution of soldiers across cycles.

Uncontrolled variables and the small number of "player" personnel made it of interest to examine, via demographic data, the comparability of the 10 groups of operators and data collectors assigned to the 10 vendors' radios. An overall summary of the demographic data is presented in Table 1. The same data are categorized by vendor in Table 2. Examination of the latter reveals that the radio (vendor) groups within a cycle were relatively similar in personnel characteristics, although some differences, particularly in the distribution of MOS's, existed between cycles. The following observations were made:

1. At least 25% of each group was composed of 11B MOS's.

2. All groups had at least one 19E MOS.

3. Group mean SQT scores were not markedly different, ranging from 75 to 83.

4. Mean prior radio operating experience did not vary widely from group to group, ranging from 3.6 to 4.4 on a five-point scale (indicating some, but "not a lot," of hands on experience or training).

5. Mean GT (ASVAB) scores across groups were not widely dissimilar. They ranged from 103 to 112.

Regarding the last point, the operators of the radio rated most trainable (see discussion below) had the lowest mean GT scores. The operators of the

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[1]Because of the length of some of the tables presented in this section, all tables have been placed together at the end of the report (prior to the Annexes) so that the narrative will remain unbroken.

radio rated least trainable were tied for the highest mean GT score with the operators of one of the second-ranked groups. Furthermore, the mean GT score of the top five radio groups (in terms of trainability) was essentially the same as that of the bottom four. The means were 108 and 109, respectively.

Similar statements can be made regarding the relationship between GT scores and operability of the radios. The two radios rated highest in operability (see discussion below) were associated with the lowest mean GT scores, while the radio rated next highest in operability was tied with the seventh ranked radio for the highest mean operator GT scores. The top five operability groups had a mean GT score of 107; for the lowest five it was 109.

Regarding the distribution of MOS's, Table 1 shows similar mean GT scores among the major MOS groups. The only apparent difference in MOS groups is seen in Table 2, where the mean time in MOS ranged from 15 to 38 months across radio groups. However, much of this difference is accounted for by the 19E MOS, which constituted only 19% of the sample.

It was concluded that the 10 radio groups were sufficiently similar in personnel to make it unlikely that demographic variables were significant factors in the MANPRINT evaluation of trainability and operability.

Post-Training MANPRINT Evaluation Questionnaire: Operator/Data Collector Evaluation of Radios, Manuals, and Training

Comparisons of radios, manuals, and training courses by item. As noted earlier, the Post-Training MANPRINT Evaluation Questionnaire contained 160 rating items on which the operators and data collectors evaluated (a) the radios on which they were trained, (b) the operator manuals, and (c) the training courses. Comparisons of the 10 radios are shown in Table 3, which presents summary statistics for each individual item on the questionnaire across the 10 radios. For each item-radio combination, the table shows the mean response (M), the number of respondents (N), and the standard deviation (SD). (Table 3 is presented as 10 subtables [Tables 3.1 through 3.10], which correspond to the general content areas covered in the questionnaire.)

With regard to Table 3, it should be noted that the vast majority of the means are positive. This finding should not, however, be interpreted in an absolute sense as implying that all of the radios are "good" from a human factors perspective. (Indeed, if these data were all negative, it would not necessarily be justifiable to conclude that all the radios were "bad.") The reason is that the perspective of most of the soldiers must be interpreted within a context that includes the current family of radios with which they are familiar: the capabilities of the new radios are substantially greater, and indeed they may be more "fun" to operate. Hence it is to be expected that the soldiers' assessments would implicitly compare the new and the old in favor of the new.

Furthermore, although the soldiers were encouraged to be objective in their assessments--and within the context there is no reason to believe that as a group they were not--soldier perspectives in operational assessments of

this kind generally tend to be of a "here-and-now" nature, in the sense that a problem that does not substantially interfere with the present mission tends to be considered less serious. Soldiers pride themselves on their ability to accomplish the mission and to demonstrate their ingenuity in overcoming obstacles that may stand in the way.

Finally, soldiers often attribute their mistakes to themselves rather than to their radio. If, for example, a certain operational procedure is momentarily forgotten, it is likely that the operator will consider the source of the problem to be "operator headspace" rather than, say, a lack of sufficient or appropriate feedback from the radio.

Within this framework it is probable that many of the human-factors characteristics of the radios that did not present themselves as urgent problems either went unnoticed or tended to be treated, not as problems, but as minor obstacles or challenges to overcome. Consequently, it is considered that the primary value of the means presented in Table 3 is not that they allow absolute judgments of the adequacy of any of the radios, but that they allow comparisons among them. However, even those comparisons must be viewed from the perspective of the soldier whose attention is justifiably directed not toward the long-term, cumulative effects of small deficiencies over the life-cycle of the materiel, but to short-term mission-related factors.

Although Table 3 does not present overall means for the items, a comparison of radios on any particular item of interest could be enhanced by calculating the mean of the means for the item and interpreting the mean for any particular radio against it. Or the means on any particular item could be rank ordered from "best" to "worst" to obtain the relative position of any particular radio within the group of radios. It should be noted, however, that differences between radios whose ranks or means are close together may not be of practical significance.

Comparisons of radios by problem area. Table 4 summarizes the data of Table 3 for each of the eight content areas pertaining to the evaluation of the radios (Tables 3.1 through 3.8). In addition, the table shows the rank order of radios within each of the major content areas on the questionnaire.

Overall comparisons of radios, manuals, and training courses. Table 5 summarizes further the information in Table 3 (3.9 and 3.10) and Table 4, and provides overall comparisons of the radios, the manuals, and the training, as determined by the operators' and data collectors' assessments taken immediately after their operator training.

It is noted that the discussion of soldier perspective presented in connection with Table 3 applies also to the interpretation of Tables 4 and 5.

MANPRINT Team Evaluation of Operator Manuals

The evaluation of the operator manuals by ARI was conducted from the perspective that operator manuals must serve two primary purposes: training

and reference. Consequently they must possess qualities that allow these purposes to be achieved both in the classroom and in the field.

First, they should consist of content that is related to effective operational performance and maintenance of the radio, but only insofar as that content is highly related to the potential operator's perspective as an operator; i.e., manuals should be to the point. In addition to the content itself, it is of great importance that the content is well referenced in indexes as well as tables of content.

Second, manuals should be able to serve as adequate training (i.e., "learning") documents. As such, they should be written and formatted in a manner that is consistent with the reading skills of the soldiers who are expected to use them.

Third, the manuals should be well illustrated: illustrations and pictures should be clear, well labeled, simple, appropriately located, etc.

Fourth, the manuals should serve as field references. As such they should be easily transportable, storable, and very durable.

Thus, the ARI evaluation of the vendors' operator manuals took into account four general areas: adequacy of content, readability, quality of illustration, and durability. Each area, except durability, was assessed on several different dimensions. They are listed in Figure 1.

Adequacy of Content	Readability
1. Table of contents	1. Type size
2. General overview	2. Paragraph length
3. Operating instructions	3. Spacing
4. Maintenance instructions	4. Sentence length
5. Trouble-shooting	5. Reading level
6. Specifications	6. Margins
7. Subject index	7. Emphasis
8. Safety hazards	
Quality of Illustration	**Durability**
1. Number	
2. Proximity to discussion	
3. Clarity	
4. Picture quality	

Figure 1. Dimensions assessed in the evaluation of the operator manuals.

The dimensions within each area and durability were each evaluated on a 3-point scale: +100 ("good"), 0 ("fair"), and -100 ("poor"). Mean ratings

for each of the three multidimensional areas were computed from the several dimensions within them. The four areas were then weighted and combined to provide a collective rating for each manual. The evaluations of the two ARI reviewers, conducted independently, were in close agreement, and were averaged together. The resulting composite evaluation for the 10 manuals is provided in Table 6, which lists the manuals in rank order from highest- to lowest-scoring.

(It should be noted that the Standard Electrik Lorenz [SEL] manual was in German and was not, therefore, used in training. Also, Ericsson [ERI] used paper copies of briefing slides as a substitute for a manual.)

Table 6 reflects rather clear differences among some of the manuals. While ITT received the most positive rating for content, Thomson (THO) and Harris (HAR) were rated highest in readability. Harris was also rated highest for illustration and durability, and was the best manual overall, achieving an overall value of +51, which on the evaluation scale falls half way between "good" and "fair." The Ericsson "manual" was, as expected, the lowest rated of all, since they did not offer a formal manual for evaluation. Excluding Ericsson, the Racal (RAC), Tadiran (TAD), and Standard Electrik Lorenz were rated the poorest manuals; they achieved similar scores on the negative side of the scale (somewhat less than "fair.")

Post-Field-Exercise MANPRINT Evaluation Questionnaire: Operator/Data Collector Evaluation of Radios:

Comparisons of radios by item. As previously stated, the Post-Field-Exercise MANPRINT Evaluation Questionnaire was completed by soldiers who had just returned from their week-long field exercise with the radio. This 230-item instrument consisted primarily of a 223-item check list that required the respondents to indicate the human-factors problems they had encountered (or were aware of) and to estimate for each problem the frequency of occurrence (if applicable) and the importance of fixing it. (Seven additional items asked questions about the operator manuals and training.)

Table 7 presents summary statistics for the 223-item check list across all 10 radios. For each item/radio combination, the table shows: (a) the number of soldiers in each vendor group who checked the item as being a problem ("frequency cited"), and (b) the mean importance-of-fix rating ("fix priority") assigned to the problem by the soldiers. (Table 7 is presented as 11 subtables [Tables 7.1 through 7.11], which correspond to the general content areas covered in the questionnaire.)

Again it is appropriate to mention the overall positive bias expected in the soldiers' responses (see discussion under Post-Training MANPRINT Evaluation Questionnaire, above). The implication is that on many of the items both the "frequency cited" and the "fix priority" may be understated. Therefore, treating the numbers as absolute rather than relative may lead to erroneous conclusions. This cautionary comment applies also to the following discussions of "problem areas" and "predominant problems."

Comparisons of radios by problem area. Cumulative frequency counts were obtained across the items within each of the 11 sections of the questionnaire to facilitate comparing radios by problem area. (The last seven items in the questionnaire are not included in this analysis because they did not pertain directly to the radios.) The results are presented in Table 8. The table also assigns a rank to each radio, where 1 implies the fewest reported problems and 10 the most. (Ranks with decimals indicate ties.) The frequencies in the table have been adjusted to compensate for unequal group sizes: The number of respondents in the Harris, Tadiran, and Thomson groups was 11; in the Ericsson, ITT, Marconi, Racal, Rockwell, and Transworld groups, the number was 12; in the Standard Electrik Lorenz group it was 13. The adjustment was computed by multiplying the total frequencies in the N = 11 groups by 12/11ths and in the N = 13 group by 12/13ths.

Table 8 also provides a composite ranking of the 10 radios in which the data from the 11 problems areas have been combined into overall ranks and total frequencies. The Standard Electrik Lorenz radio was ranked first, with the fewest problems cited. The radio with the greatest number of problems cited--approximately three times as many as for the Standard Electrik Lorenz--was the Thomson. The radios whose total problem frequencies were above average were from least to most: ITT and Racal (tied), Harris, Rockwell, and Thomson.

Predominant problems. Those problems that were cited in the Post-Field-Exercise MANPRINT Evaluation Questionnaire (Table 7) by more that 30% of the respondents of any vendor group have been compiled in Tables 9.1 through 9.11 and summarized in Table 9.12. Table 9.12 also rank orders the radios from least to most problems cited by 30% or more of the respondents.

A number of problems listed in Table 9 were exhibited by 50% or more of the radios. Those problems and their corresponding item numbers (from the questionnaire) are as follows:

1. Static (005)
2. Audibility of handset in background noise (008)
3. VINSON-related degradation of communications (010)
4. Data transmission in frequency-hopping mode (027)
5. Readability of control panel in low light (033, 133, 216)
6. Readability of display from an angle (057)
7. Visual discernment of knob setting from an angle (107)
8. Crowding of connector receptacles (145, 156)

This core of problems common to many of the radios may have *general* relevance to future design criteria. Their pervasiveness and the identification of the radios for which they are reported may be discerned from Table 9.

Trainability (Comparison of Radios)

Common-task operator-performance evaluation. This evaluation attempted to compare the 10 radios on the amount of time required for operators to perform certain general tasks common to the operation of each of the radios. Such a

comparison offered a valuable index of the operational complexity of the radios (under the assumption that the greater the time required to complete the performance tasks, the greater the complexity). (It was also argued that the greater the variability within radio groups in the time required to complete the tasks, the more difficult the tasks.)

Unfortunately, the attempt to provide a trainability index based upon the performance of common tasks was unsuccessful because of the largely uncontrolled circumstances (from a scientific perspective) in which the performance data were collected. The data for the 10 vendor groups were collected on different occasions by different instructors whose exams and examination procedures varied. For example, the number of frequencies that the instructors required their trainees to load into the radio to test single-channel operations varied from one to nine. Similar discrepancies occurred in the number of channels required to be programmed for frequency-hopping mode. Also, for some radios, but not for others, operators were required to perform verbal communications checks to confirm that proper information had been loaded into the radio. Furthermore, performance times for certain operating procedures were not collected for all radios, and the data collected for two radios were lost. Hence, it was not possible to obtain satisfactory, standardized common-task performance measurements; and a major insight into both the trainability and operational complexity of the 10 radios was thus precluded.

Evaluation of trainability. As an alternative to the common task procedure, several key questions from the post-training and post-field-exercise questionnaires were combined with the data from the operator manuals evaluation by ARI (Table 6) to construct a trainability index. The questionnaire items covered five trainability factors: optimal course length, optimal course difficulty, the degree to which the courses were interesting, the adequacy with which the courses prepared the soldiers to operate the radios in the field, and the overall quality of the courses. The results are shown in Table 10.

Examination of the table reveals several things:

1. All operator groups except ITT and Thomson indicated a need for a reduction in the amount of classroom training time (i.e., four days or less). The ITT and Thomson operators indicated a need for an increase--at least five days of training. However, the perceived need for training increased across all groups after the week-long field exercise. Furthermore, three of the four groups that indicated the greatest training requirement before the field exercise showed the greatest increases in perceived training requirement after the field exercise.

2. There was little distinction from group to group in their perceptions of optimal course difficulty. In general, the difficulty level was considered satisfactory.

3. The ITT, Harris, and Rockwell groups exhibited the least favorable ratings of course interest level, although the level was viewed as satisfactory. The Marconi and Racal courses received the highest interest level ratings.

4. In general, the soldiers felt that their training constituted adequate preparation for operating the radio in the field. The least positive perceptions of adequacy (although within the acceptable range) were for the ITT radio; the most positive perceptions were for the Marconi and Transworld radios.

5. With respect to overall course quality, there is little distinction to be made except in the case of ITT, which appeared to be rated somewhat lower than the others--but nevertheless well within the satisfactory range.

6. The operator manuals were discussed earlier (see Table 6).

It terms of overall trainability, the Marconi radio was rated highest, with Harris and Transworld close behind. ITT was the lowest and apparently substantially below the next lowest, Racal and Thomson.

The overall means from Table 10 are graphically portrayed in Figure 2.

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|                                                 |
|                          ↑                      |
|                        /2.0                     |
|                       /  .                      |
|                      /   .                      |
|                     /    .                      |
|                    /    2.4          MAR        |
|                   /     2.5        HAR TWC      |
|        Good 1 -| /      2.6          ROC        |
|                |/       2.7        SEL TAD      |
|             2 -|        2.8          ERI        |
|                |        2.9        RAC THO      |
|-------Fair-3--|---------3.0---------------------|
|                |        3.1          ITT        |
|             4 -|         .                      |
|                |\        .                      |
|        Poor 5 -| \       .                      |
|                   \      .                      |
|                    \     .                      |
|                     \    .                      |
|                      \   .                      |
|                       \  .                      |
|                        \4.0                     |
|                          ↓                      |
|                                                 |
---------------------------------------------------
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Figure 2. Trainability comparison. (Radios on the same line were tied.)

In interpreting these trainability findings, it is important to consider the individual characteristics and capabilities of each of the radios and the

degree to which they meet Army needs and requirements. The Transworld and Standard Electrik Lorenz radios, for example, are incapable of frequency hopping and should, therefore, be inherently simpler to operate. Regarding these two radios, it is noted that while Transworld tied for second place in the trainability ratings, the Standard Electrik Lorenz fell in the middle of the pack. At the other end of the spectrum, the ITT radio was rated the lowest in trainability; but it is a frequency-hopping radio with many features and capabilities; and the advent of the ITT integrated COMSEC radio may solve problems experienced by many of the radios in interfacing with the VINSON KY-57 (see Table 9).

A number of written comments related to training were made by the soldiers, particularly on the Post-Training MANPRINT Evaluation Questionnaire. The salient contents of those comments were:

1. There should be more hands-on experience in realistic settings: radios mounted in vehicles, etc. (One-half day was allotted to this kind of training during the courses.)

2. Hands-on net operations during the training course should provide greater physical separation among stations to support realism and independent effort.

Operability (Comparison of Radios)

As with the trainability evaluation, the initial intent of the operability evaluation was to base an ease-of-operation index on the performance of tasks common to the operation of all the radios. However, for the reasons discussed previously, that approach was precluded.

An alternative evaluation based upon soldier assessments was made by combining information from three sources: (a) the post-training soldier evaluation of the radios (Table 5), (b) the total number of problems cited by the soldiers for each radio after the field exercise (Table 8), and (c) the number of predominant problems recorded for each radio after the field exercise (Table 9.12). Source (a) constitutes the soldiers' impressions upon completion of their training. Source (b) was primarily a product of the soldiers' experiences with the radios during the tactical field exercise and, as such, contributes information based upon realistic operations. Source (c) weights the evaluation by emphasizing the most reliable findings--those reported by more than 30% of the soldiers in each radio group.

The three sources of operability information are summarized in Table 11. The frequency data in the table were converted to values on a five-point scale where "1" was the most favorable and "5" was the least favorable (i.e., from "good" to "poor").

In order to convert the frequencies in Table 11, it was necessary to assume some underlying scale properties. For those frequencies obtained from Table 8 the mean was 304. In addition, the lowest and highest frequencies were roughly equidistant from the mean. The entire underlying frequency range

was then assumed to extend in a symmetrical distribution from 0 to 608. The underlying distribution was also assumed to be normal, which implies that frequencies above 608 would be expected to be extremely rare.

The same kind of process was used to convert the frequencies in Table 11 that were taken from Table 9.12. In this case, the mean of the frequencies was 25. Again the lowest and highest were approximately equidistant from the mean. The underlying distribution was assumed to be normal and to extend from 0 to 50.

Figure 3 provides an operability comparison of the radios by averaging the three scale values from Table 11 for each radio.

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--------------------------------------------------
|                                                |
|                        ↑                       |
|                      /2.0       MAR SEL        |
|                     / 2.1                      |
|                    /  2.2         TWC          |
|                   /   2.3                      |
|                  /    2.4         TAD          |
|                 /     2.5                      |
|       Good 1 -| /     2.6                      |
|               |/      2.7         ERI          |
|            2 -|       2.8                      |
|               |       2.9         RAC          |
|-------Fair-3--|--------3.0----------ITT--------|
|               |       3.1         HAR          |
|            4 -|       3.2         ROC          |
|               |\      3.3                      |
|       Poor 5 -| \     3.4         THO          |
|                  \     .                       |
|                   \    .                       |
|                    \   .                       |
|                     \  .                       |
|                      \ .                       |
|                       \4.0                     |
|                        ↓                       |
|                                                |
--------------------------------------------------
```

Figure 3. Operability comparison. (Radios on the same line were tied.)

As was the case with the trainability comparison shown in Figure 2, in interpreting these operability findings it is important to take into account characteristics and capabilities of each of the radios and the degree to which they meet Army needs and requirements. Furthermore, this "operability" evaluation must not be equated with an evaluation of the complexity of the radios. Rather it consists primarily of a summary of human-factors-related problems

cited by the soldiers. It does not take into account the detailed human-factors findings of the MANPRINT team, which are presented in the second results section of this report.

ITT SINCGARS Learning-Retention Test Results

[At the time of this writing, this section of the report also exists as a separate draft document to be published as an U.S. Army Research Institute Research Report entitled "SINCGARS Operator Performance Decay." The version of the document presented here is not the final and is pending revision prior to publication based upon peer reviews.]

[Continued on Next Page]

RESEARCH REPORT

SINCGARS OPERATOR PERFORMANCE DECAY

Richard L. Palmer and Louis W. Buckalew

Fort Hood Field Unit

December 1987

U.S. Army Research Institute
for the Behavioral and Social Sciences
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The Single-Channel Ground/Airborne Radio System (SINCGARS) is scheduled to replace the Army's VRC-12 and PRC-77 radios. But SINCGARS is more complex to operate and requires more training. This study examined the decay of operational skills and knowledge in two groups of recently trained operators who went without exposure to SINCGARS for several weeks. Performance levels were measured with the SINCGARS Learning-Retention Test (SLRT), a simulated hands-on performance test emphasizing skills and operational knowledge retention. The results provided tentative indications that operators may lose about 10% of their prior performance levels within the first few weeks. This figure is expected to vary considerably, depending on the type of soldier, the length of the non-exposure period, and other conditions. It was also found that performance level was correlated with soldiers' ASVAB GT scores. Correlations between GT and SLRT scores obtained at two different times were .43 and .50. However, no relation was observed between performance decay and GT. Further evaluation of operator performance decay needs to be done to determine the effect of longer periods of non-exposure (e.g., 60 and 90 days).

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Inside Title Page

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FOREWORD

As part of its overall mission, the Army Research Institute (ARI) conducts MANPRINT-related research in the areas of manpower, personnel, and training. The research reported here concerns the Single-Channel Ground/Airborne Radio System (SINCGARS), developed by ITT Corporation and currently undergoing user testing within the Army's materiel acquisition process. The report addresses the SINCGARS operator's problem of learning and retaining the operational skills and knowledge required to use this complex radio system successfully. It also provides groundwork for planned evaluations of SINCGARS training.

The project, part of the Fort Hood Field Unit's research on "Manpower, Personnel, and Training Considerations in User Testing," was conducted pursuant to "Letter of Agreement between the U.S. Army Research Institute for the Behavioral & Social Sciences and U.S. Army Operational Test and Evaluation Agency," June 1983. The report was provided in December 1987 to the following U.S. Army organizations: the Operational Test and Evaluation Agency (SINCGARS Test Evaluator), the Training and Doctrine Command (SINCGARS System Manager), the Communications and Electronics Command (SINCGARS Project Manager), and the Test and Experimentation Command (SINCGARS Test Officer). It provides information relevant to determining the need for further SINCGARS training evaluations as well as to the planning of remedial and maintenance-of-skills training programs.

EDGAR M. JOHNSON
Technical Director

SINCGARS OPERATOR PERFORMANCE DECAY

EXECUTIVE SUMMARY

Requirement:

The Single-Channel Ground/Airborne Radio System (SINCGARS) is intended to replace the current VRC 12 and PRC 77 series radios. While SINCGARS offers far greater capability than its predecessors, it does so at the cost of greater operational complexity. Hence, SINCGARS places a greater cognitive burden on operators and trainees than current radios and creates a need for enhanced training programs. The exploratory field study reported here was performed by the Army Research Institute (ARI) to determine (a) the effect of the absence of practice on the post-training performance level of operators over time and (b) the relation between the ASVAB GT scores of operators and post-training performance. The research was conducted in conjunction with non-scheduled user testing by the U.S. Operational Test and Evaluation Agency at Fort Riley and by the SINCGARS Project Manager at Fort Gordon.

Method:

Operator performance was measured with the SINCGARS Learning-Retention Test (SLRT), a simulated hands-on SINCGARS performance test constructed by ARI. Two sets of data were obtained: (a) from 12 combat arms soldiers from the 1st Infantry Division, Fort Riley, 1986 (Group CA); (b) from 46 communications-electronics soldiers from the 67th Signal Battalion, Fort Gordon, 1986-87 (Group CE). Both groups were administered the SLRT after SINCGARS exposure (training and field exercise) and again after an interval with no practice or other exposure to the radio.

The schedule of events for Group CA was: 30 hours instruction, 2 days non-exposure to SINCGARS, 4.5 days field experience, 2 days non-exposure, 1st SLRT, 5.5 weeks non-exposure, 2nd SLRT. The schedule for Group CE was: 25 hours instruction, 10 days non-exposure to SINCGARS, 11 days field experience, 8 to 18 days non-exposure, 1st SLRT, 10 weeks non-exposure, 2nd SLRT.

In addition ASVAB GT scores were obtained for the groups from unit personnel files. These scores were evaluated for possible correlation with performance on the SLRT.

Findings:

Both groups exhibited a statistically significant decay in performance level from 1st to 2nd SLRT administration. The average individual decay for Group CA was 10%; for Group CE, however, it was only 3%. Examination of the schedule of events for the latter group suggests, however, that some decay

probably occurred prior to the first SLRT administration during the 8-to-18 day non-exposure interval between the field exercise and the 1st SLRT. Therefore, the Group CA figure (10%) was taken to be more indicative of what might be expected during the first few weeks of non-exposure. However, the validity and practical significance of both figures (10% and 3%) remain to be determined, as does the amount of decay over longer periods of time (e.g., 60 & 90 days).

The statistical correlation between the operators' GT scores and their performance scores on the SLRT was .43 for the 1st SLRT administration and .50 for the 2nd for both groups combined. These coefficients indicate that, on the average, about 22% of the variance in SLRT scores can be predicted by GT scores. This would appear to bear some practical significance, but, again, the validity of the result needs to be further established.

Utilization of Findings:

These findings will assist in the development of SINCGARS training programs and evaluations by the Training & Doctrine Command, the Operational Test & Evaluation Agency, the Communications & Electronics Command, and other organizations involved in the acquisition of the SINCGARS system. The results of this research, though preliminary, suggest a need to consider that the properly-trained SINCGARS operator, through no fault of his own, may become unable to operate the radio in a satisfactory manner if a substantial period of non-exposure to the radio occurs. Some attention may need to be given to the possible development of programs of periodic remedial, or refresher, training.

SINCGARS OPERATOR PERFORMANCE DECAY

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Introduction

The Single-Channel Ground/Airborne Radio System (SINCGARS) under development by ITT Corporation, Aerospace/Optical Division, is contractually slated to become the Army's primary tactical net radio system. The new system will replace the antiquated PRC-77 and VRC-12 series radios. It is estimated that approximately 300,000 of the new radios will be fielded--16,000 of the so-called production model and the remaining an upgraded model that incorporates an integrated communications security (ICOM) model.

The ITT SINCGARS, because of its advanced electronic and operational complexity, gives rise to new challenges for the operator and operator training programs. Basic principals of learning indicate that, as the task complexity of a system increases, there is not only a concomitant increase in learning time but also in the potential for both post-learning interference and decay, especially in the absence of periodic practice. Hence, the impact of these variables on SINCGARS operator performance has become of concern to the Army.

Responsibility for the operational testing of SINCGARS is assigned to the Army's Operational Test and Evaluation Agency (OTEA), and OTEA has conducted all operational tests of the system to date. However, future operational testing will be conducted by the Army Test and Experimentation Command (TEXCOM), with OTEA acting as Independent Evaluator. The Army Research Institute (ARI) has participated in the SINCGARS operational testing program under the primary sponsorship of OTEA, but also in cooperation with the Training and Doctrine Command (TRADOC), the Communication and Electronics Command (CECOM), and the TRADOC Combined Arms Test Activity (TCATA, precursor to TEXCOM), and has conducted human factors and other MANPRINT-related SINCGARS studies since the inception of SINCGARS operational testing in 1982.

The purpose of this report is to summarize ARI's MANPRINT findings concerning the SINCGARS operator's retention of learned operating skills and knowledge over time. The research focused on determining (a) how much learning decay occurs over time in the absence of practice, and (b) if there is a relation between operators' General Technical (GT) scores[1] on the Armed Services Vocational Aptitude Battery (ASVAB) and their post-training levels of skill and knowledge (and, by inference, training assimilation).

ARI first obtained data pertaining to SINCGARS operator skills and knowledge retention in 1983-84 in association with OTEA's "Maturity Operational Test" (MOT) at Fort Riley, Kansas. Later, on two occasions, ARI collected additional data. The first occasion was in conjunction with a special "Non-Developmental Item" (NDI) Operational Assessment conducted by OTEA at Fort Riley in the fall of 1986. The NDI assessment was an Army response to unanticipated delays in the acquisition of the ITT SINCGARS. The intent of the

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[1]The GT is a composite score based on certain arithmetic reasoning and verbal subscales of the ASVAB.

assessment was to determine whether any currently available "off-the-shelf" (non-developmental) radios would suffice as interim replacements for the PRC-77 and VRC-12 radios. Ten vendors (including ITT) submitted radios for evaluation. The ITT SINCGARS was included for comparison purposes. Also, after the NDI assessment, ARI obtained retention data in late 1986 and early 1987 from SINCGARS-trained operators in the 67th Signal Battalion at Fort Gordon, Georgia. These soldiers had participated in a special SINCGARS evaluation sponsored and conducted by the SINCGARS Project Manager (PM). The present report deals primarily with the latter two groups; i.e., Fort Riley (1986) and Fort Gordon (1986-87), which for convenience shall be referred to in the remainder of this report as the Combat-Arms Group (Group CA) and the Communications-Electronics Group (Group CE), respectively.

Method

Participants

The first column of Table 1 lists the Military Occupational Specialties (MOS) of the cavalry and artillery soldiers from whom early retention data were gathered during 1983-84 in conjunction with the SINCGARS MOT. Of the 24 cavalry soldiers, 23 participated in a second administration of the SLRT and 10 in a third. Of the 29 artillery soldiers, 27 were present for a second administration and 6 for a third.

Group CA. During the NDI Operational Assessment at Fort Riley, 12 combat arms soldiers, including 1 officer, were trained as operators of the ITT SINCGARS radio. The middle column of Table 1 shows the MOS distribution for these soldiers. The column heading gives their mean ASVAB GT score. The individual GT scores ranged from 95 to 128. Eleven of the 12 soldiers participated in both an initial and a subsequent administration of the SINCGARS Learning-Retention Test (see Instrument, below).

Group CE. The right-hand column of Table 1 presents the MOS distribution for 46 SINCGARS-trained operators from the 67th Signal Battalion at Fort Gordon. The column heading shows the mean GT score, which ranged from 86 to 127, with the exception of one low score of 71. (The frequency distribution for the MOSs was not obtained.) Of these 46 soldiers, 29 completed both the initial and subsequent administrations of the learning-retention test.

Composite GT. The composite mean GT for the two groups of SINCGARS operators was 106.9, with a standard deviation of 11.8. The composite distribution of GT scores is shown in Figure 1.

Instrument: SINCGARS Learning-Retention Test (SLRT)

The purpose of the SLRT, constructed by ARI during the 1983 SINCGARS MOT, was to provide an efficient measure of the SINCGARS operator's skill and knowledge levels. The instrument was updated during the 1986 NDI Operational Assessment to correspond to changes in the radio and training. It was also reviewed by ITT subject-matter experts to ensure the validity of its contents.

Table 1

MOS Distribution and Mean GT Scores of Operator Groups

Previous Study				Present Study			
1983-84 (MOT) Cavalry --[a]		1983-84 (MOT) Artillery --[a]		1986 (NDI) Group CA (Mean GT = 112.1)		1986-87 (PM Eval.) Group CE (Mean GT = 105.3)	
MOS	n	MOS	n	MOS	n	MOS	n[b]
05B	1	:		:		:	
05C	3	:		:		:	
:		:		11B	3	:	
:		:		12B	1	:	
:		13C	4	:		:	
:		13E	5	:		:	
:		13F	7	:		:	
:		13M	8	:		:	
:		15J	2	:		:	
16S	1	:		:		:	
19D	9	:		:		:	
19E	5	:		19E	3	:	
:		:		:		26Q	--
:		:		31C	3	:	
:		:		:		31K	--
:		:		:		31M	--
31V	1	31V	1	31V	1	:	
:		34V	1	:		:	
:		:		:		36C	--
36K	1	36K	1	:		:	
63N	1	:		:		:	
:		:		:		72E	--
76Y		:		:		:	
:		:		93P	1	:	
96B	1	:		:		:	
Total:	24		29		12		46

[a]GT scores not obtained.
[b]The frequency distribution for Group CE MOSs was not available.

The paradigm for assessing skills and knowledge loss over time required two administrations of the SLRT separated by a time interval. To minimize practice effects from taking the same test twice, a parallel form of the SLRT (Form B) was also constructed (for both the original and updated versions).

The two forms (A and B) of the SLRT are analogous paper-and-pencil tests, each with two sections. Part 1 is a skill-oriented, simulated performance test that emphasizes the ability to perform radio operating procedures. The

more recent version consists of the following seven operational tasks on which the soldier can score a maximum of 256 total points:

- Test RT memories.
- Load and store TRANSEC variable.
- Load and store hopset.
- Load date and time of day.
- Send (ERF) a hopset for net update.
- Receive and store hopset ERF from NCS during net update.
- Load a minus offset.

Part 2 of the SLRT is knowledge oriented and places emphasis on procedures and their outcomes. It consists of 12 multiple-choice questions on which there are 152 points possible. A simple combination of Parts 1 and 2 provides a maximum possible score of 408.

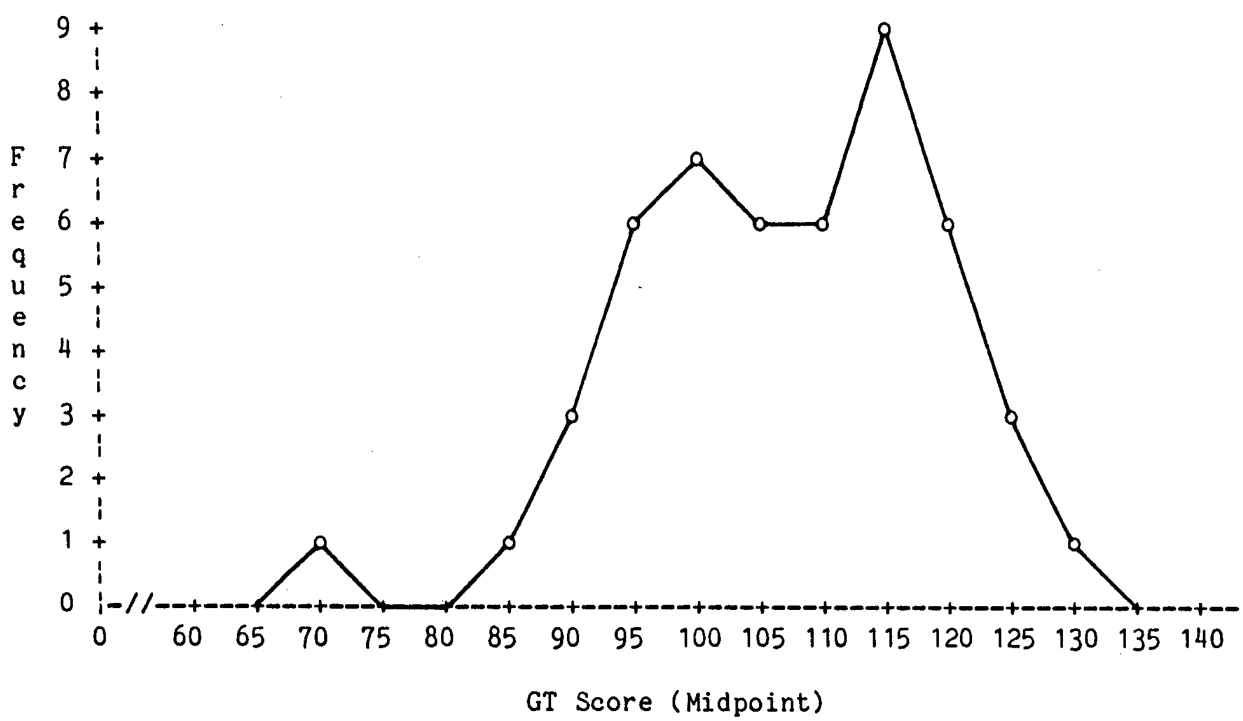

Figure 1. Composite distribution of radio operators' GT scores ($\underline{n}$ = 49); Groups CA and CE combined.

<u>Equivalence of forms</u>. A comparison of Form A ($\underline{n}$ = 23) and Form B ($\underline{n}$ = 23) on the first administration for Group CE yielded a mean of 270 for Form A and 273 for Form B. The corresponding standard deviations were 68.9 and 56.2, respectively. The $\underline{t}$ value resulting from a test of this difference was .19 ($\underline{p}$ > .40), which attested to the statistical equivalency of the two forms.

Procedure

Group CA received approximately 30 hours of classroom operator training and 4.5 days of subsequent field experience with the radio. Group CE received 25 hours of classroom training and 11 days of field experience. The operators were then administered the SLRT in group settings (the CA group at Fort Riley, the CE group at Fort Gordon). Approximately half the operators at each site received Form A; the other half received Form B. Twelve operators in Group CA and 46 operators in Group CE participated in the first administration. The second administration, which used the alternate form for each soldier, was conducted at the respective sites 5.5 weeks (Group CA; n = 11) and 10 weeks (Group CE; n = 29) after the first administration.

No time limit was placed on the test administration, and every effort was made to ensure the integrity of individual test performances. As each soldier finished (usually within 40 minutes), his or her test was reviewed by one of the two test administrators (ARI research psychologists) to ensure that all items had been answered. All tests were scored by the same individual.

Findings

Limitations

While there were appreciable similarities between the two groups of operators, there were also important differences that might affect the interpretation of results. Major differences in sample composition and treatment procedures are listed in Table 2.

Decay Analysis: Group CA

Baseline. The SLRT scores from the first administration for all soldiers in the CA group (n = 12) ranged from 140 to 400, with a mean of 294 (72%) and a standard deviation of 68.5. For the 11 soldiers who were subsequently present for the second administration, the first administration mean and standard deviation were 300 (74%) and 68.9, respectively.

Decay. The SLRT scores on the second administration ranged from 180 to 353 (n = 11). The mean was 263 (64%); the standard deviation was 53.4. Thus, the second administration mean was lower. The difference between the means was tested for significance with a correlated t test. The probability of the resulting value, t = -2.81 (df = 10), was less than .02. The mean individual operator decay from the first to the second administration was 10%.

Decay Analysis: Group CE

Baseline. The mean SLRT score for all soldiers in the CE group (n = 46) on the first administration was 271 (66%). The range of scores was 124 to 388, and the standard deviation was 62.2. For those operators present at the second administration (n = 29), the first administration mean and standard deviation were 278 (68%) and 69.1, respectively.

Decay. The SLRT scores on the second administration ranged from 142 to 400. The mean was 267 (65%; n = 29), which, as in Group CA, was lower than the first administration mean. The standard deviation was 65.9. The difference between the means from the first and second administrations was statistically significant (correlated $t = -2.06$, $df = 28$, $p < .05$). The mean individual decay from first to second administration was 3%.

Table 2

Comparison of SINCGARS Operator Samples

Variable	Group CA	Group CE
Sample size[a]	12 & 11	46 & 29
Instruction	30 hours (by Sig. Sch.)	25 hours (by ITT)
Class size	12	15 to 16
Time between instruction & field experience	2 days	10 days
Length of field experience	4.5 days	11+ days[b]
Time between field experience & first SLRT	2 days	8 to 18 days
Time between SLRT tests	5.5 weeks	10 weeks
Operator MOSs	12B, 19E, 11B, 31C, 31V, 93P	26Q, 31K, 31M, 36C, 72E
Mean ASVAB GT	112.1	105.3

[a]First and second SLRT administrations.
[b]Five or 6 operators had small amounts of additional SINCGARS experience on special Signal Center tests.

Decay Analysis: Composite Sample

Several factors argued against combining the Fort Riley (Group CA) and Fort Gordon (Group CE) samples (see Table 2). The comparability of the samples was threatened by differences in MOS, the length of field experience with the radio, and the amount of time intervening between SLRT administrations. The soldiers in Group CA were predominantly in combat arms MOSs, whereas the soldiers in Group CE were in communications-electronics operations MOSs. Furthermore, Group CE soldiers had more field experience with the radio, longer time intervals between instruction and field experience and between field experience and the first SLRT administration, and nearly twice as long an interval between SLRT administrations as Group CA.

Groups comparison, baseline. Even with the differences cited, however, the disparity between Groups CA and CE on the baseline administration was fairly small. When the two means for the total samples (294 [n = 12] & 271 [n = 46], respectively) were compared with a t test for independent samples, the probability of the obtained t value, 1.10 (df = 56), was greater than .25. Figure 2 portrays the means graphically. (A similar comparison of the first-administration means for only those operators who participated in both administrations, 300 [n = 11] and 278 [n = 29], respectively, resulted in a t value of .87 [df = 38], which was also nonsignificant [$p > .20$]).

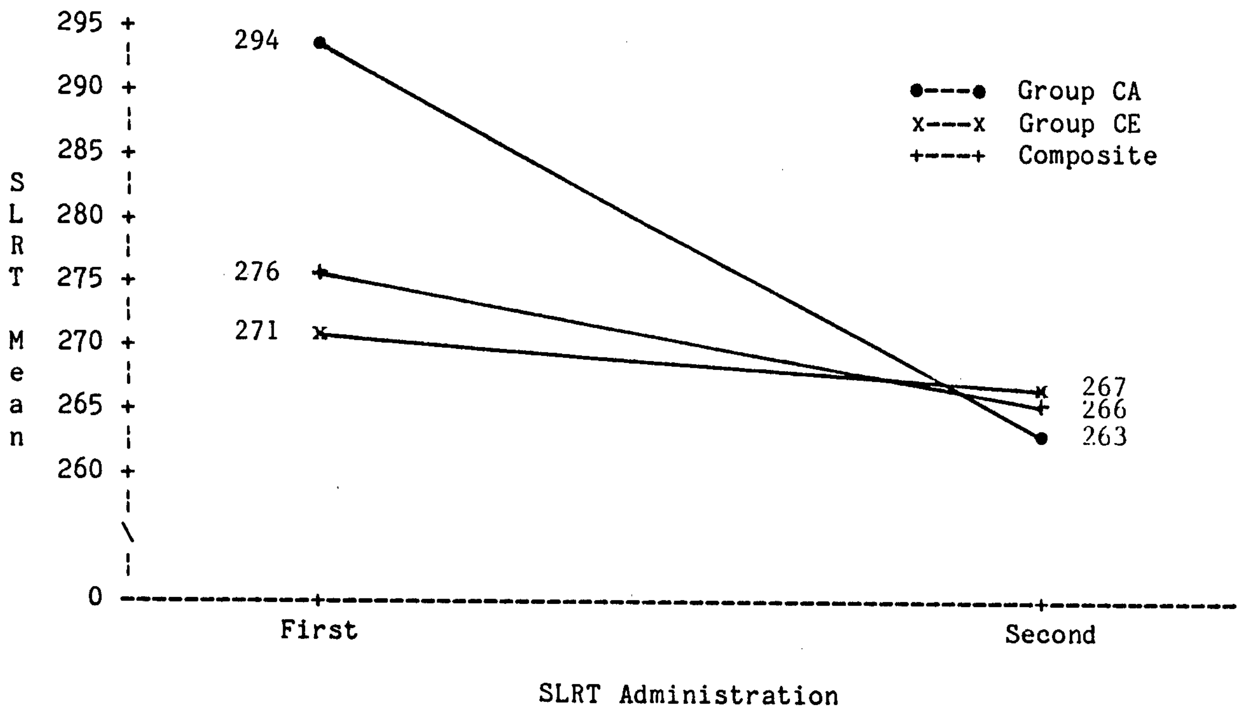

Figure 2. Comparison of Groups CA and CE on the SLRT. The points plotted are means based on all respondents for that administration.

Groups comparison, decay. The second-administration means, which were very similar to each other (263 and 267), are also portrayed in Figure 2. The difference was considered inconsequential and was not tested statistically.

Decay, composite sample. Because of the statistical similarity between Groups CA and CE and between Forms A and B of the SLRT, the scores of those operators from both groups who participated in both first and second administrations (n = 40) were combined. The composite means for the two administrations (284 and 266 respectively) were compared with a correlated t test. The resulting t value, -3.28 (df = 39), was significant (p <. 01).

In addition, the first-administration scores from the two groups (n = 58; range 124 to 400) were combined into a general baseline. The mean and standard deviation were 276 (see Figure 2) and 63.6, respectively. However, because not all of these soldiers were available for the second administration

of the SLRT, the calculations were made for future reference only and were not used in the analysis. (The 18 soldiers not present for the second administration had a lower mean first-administration test score [258] than the 40 who were present [284]. Of the 18, 17 were in Group CE. A t test of the difference between the mean first-administration score [259] of the 17 and the mean first-administration score [278] of the 29 from Group CE who attended the second-administration was nonsignificant [t = .99, df = 44, p > .20].)

Figure 3 shows the percentages of operators whose scores fell within successive intervals of the SLRT range. The decay hypothesis implies higher scores during the first administration and lower scores during the second administration; therefore, more operators were expected in the higher intervals during the first administration and more in the lower intervals during the second administration. Figure 3 tends to confirm these expectations.

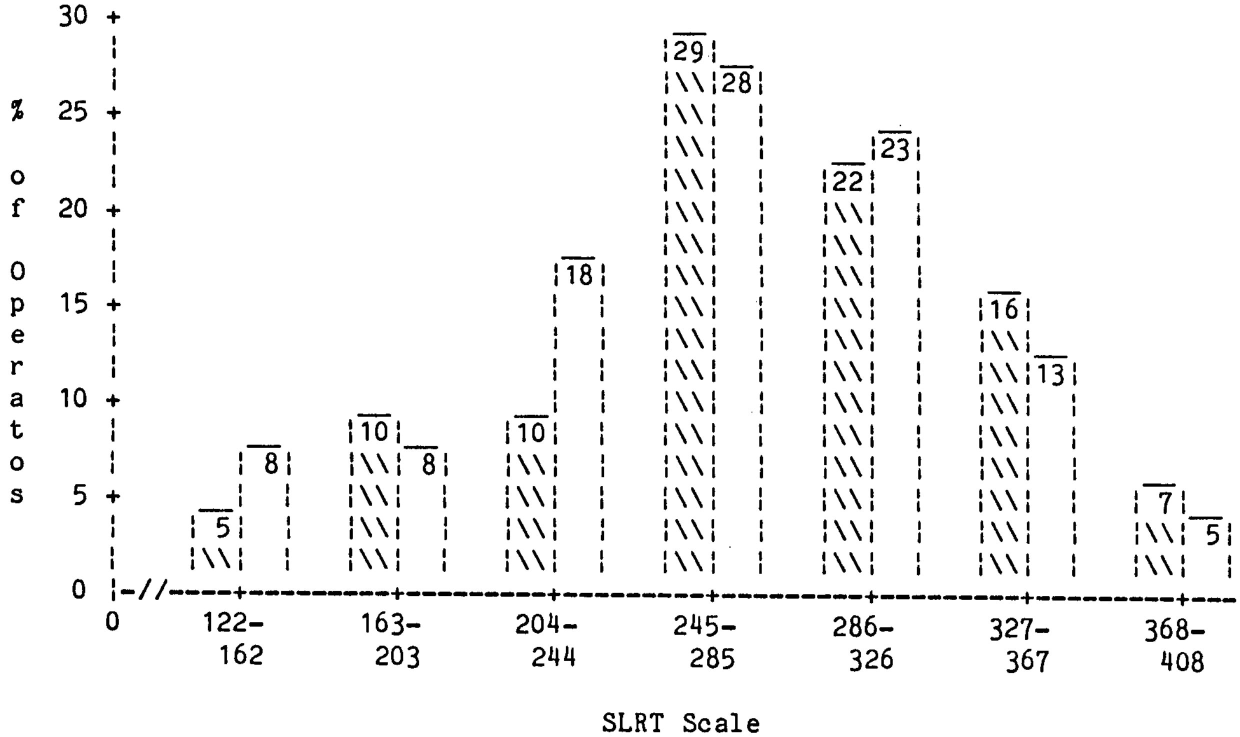

Figure 3. Comparison of 1st (cross-hatched bars) and 2nd (open bars) SLRT administrations. The interval between administrations ranged from 5.5 to 10 weeks.

ASVAB GT Scores, Composite Sample

The Pearson product-moment correlation between the operators' GT scores and first-administration SLRT scores was .43 (n = 48). For the second administration, the correlation was .50 (n = 39). Both coefficients were significant (p <. 01), indicating that the higher the operator's GT score, the better his or her initial and subsequent performance levels.

The correlation between GT scores and individual decay percentages, however, was not significant: $\underline{r}$ = .01 ($\underline{n}$ = 39). Nor was the point-biserial correlation between GT scores and whether or not individual decay occurred: $\underline{r}_{pb}$ = .06 ($\underline{n}$ = 26, 13). The probability level for both coefficients was greater than .20.

Discussion

In 1983-1984, SINCGARS performance decay was assessed in connection with the Maturity Operational Test (MOT) at Fort Riley. With the original version of the SLRT and a classroom training and field-experience scenario similar to that of the present Fort Riley sample (Group CA), a group of 23 cavalry soldier-operators experienced a mean post-training, post-field-test decay of 2% following 3.5 weeks of non-exposure to SINCGARS. After seven months of non-exposure, the decay had increased to an average of 10% for the 10 operators still available for testing. In contrast, a group of 27 artillery soldiers showed an unexpected 5% decay immediately after 3.5 weeks of intensive field exposure following formal classroom training. Six of the operators who remained in the sample after seven months experienced an overall decay of 31%. Thus, the original data from the 1983-84 study were somewhat difficult to interpret: The cavalry soldiers exhibited a relatively small amount of decay, even after seven months; the artillery soldiers, however, experienced a relatively large decay, but 20% of it was already in evidence following an initial period of SINCGARS training and practice.

The results of the more recent research described here are also limited --by their descriptive nature (since SINCGARS was not compared to current radios) and by several uncontrolled variables inherent in the conditions under which the research had to be conducted: (a) Group CA had more classroom instruction (30 vs. 25 hours) and smaller classes than Group CE; (b) Group CA had less field-exercise experience with SINCGARS than Group CE (4.5 versus 11 days); (c) the classroom instruction for Group CA was provided by ITT-trained TRADOC instructors instead of by the ITT experts themselves, as for Group CE; (d) for Group CA, two days of non-exposure to SINCGARS intervened between the completion of their post-training field exercise and the first administration of the SLRT; for Group CE, there were varying intervals of 8 to 18 days (or more, in a few cases); (e) the interval (including a field exercise in which the operators used the radio extensively) between the completion of classroom training and the first SLRT was 9 days for Group CA and 29 to 39 (or more) days for Group CE.

Nevertheless, several interesting findings and hypotheses related to SINCGARS training and retention emerged from this study:

1. The level of SINCGARS operational skills and knowledge, as measured by the SLRT (both initial and subsequent administrations), was related to the operator's composite arithmetic and verbal performance on the ASVAB. The proportion of variance in SLRT performance accounted for by GT scores ranged from 18 to 25 percent.

2. The amount of post-training learning decay during the six weeks immediately following a period of intensive training and field exercise was 10%,

which was statistically significant. Whether this decay translates into practical significance in terms of operational proficiencies is, as yet, an unanswered question. It appears that SINCGARS performance decay is rapid at first, but this study does not indicate what the long-term (e.g., 30, 60, and 90 day) effects of non-exposure may be, which is important knowledge for unit and remedial training programs. Furthermore, no determination about what constitutes acceptable levels of initial and retained learning can be made from the present SLRT data. This issue will be addressed during the SINCGARS Follow-On Test and Evaluation, the next scheduled operational test of SINCGARS.

3. The varying non-exposure delays prior to the administration of the first SLRT could have allowed appreciable decay to go undetected. The relatively immediate SLRT for Group CA yielded a mean score of 294, compared to 271 for the more delayed testing for Group CE. Although the difference between these means was not statistically significant, had the Group CE delay been shorter, their mean might have been higher. In other words, the difference in initial SLRT scores might have been due to unmeasured decay.

4. The two operator groups performed quite similarly on the second SLRT administration (263 for Group CA; 267 for Group CE). The initially higher Group CA mean dropped 31 points, versus 4 points for Group CE. Considering the difference in time intervals between the first and second SLRT administrations for Groups CA and CE (5.5 and 10 weeks, respectively), the small difference remaining between the group means suggests that, as is typical of curves of complex learning, operator skills and knowledge tend to decline rapidly at first and then more slowly, tending to stabilize. In this case, the Group CE scores seem to have been relatively stable in the absence of practice for at least 10 weeks.

5. The smaller (though statistically significant) decay for the Group CE operators, even with a longer period of non-exposure to SINCGARS, may have been related to the soldiers' MOSs. The Group CE soldiers from the 67th Signal Battalion (Fort Gordon) had communications-electronics MOSs, whereas the Group CA operators from the 1st Infantry Division (Fort Riley) had predominantly combat arms MOSs. It is possible, then, that the Fort Gordon operators might have ascribed more "meaningfulness" to their SINCGARS training and, consequently, better integrated their learning. Thus, the data suggest that MOS may be related to training effectiveness and performance via the extent to which the operator perceives a vested interest in the training.

Conclusion

The additional complexity and expanded operational capability of the SINCGARS tactical net radio, relative to the current PRC-77 and VRC-12 radios, strongly suggest that SINCGARS will require more training, place greater demands on the learner in developing operational competence, and be more prone to operator learning decay when operators do not engage in periodic practice.

It is clear that operating the SINCGARS radio is a complex task that will require practice if operator proficiency levels are to be maintained at high levels. However, certain SINCGARS training, performance, and decay variables

need further evaluation. They include the effects of longer intervals of non-exposure to SINCGARS, the operator's MOS and other bio-demographical characteristics, and quantifiable performance factors such as critical task completion times, message completion rates, problems encountered, and error rates.

The SINCGARS Follow-On Test and Evaluation, scheduled to start in 1988, will provide an opportunity to study some of these issues.

RESULTS SECTION 2: DETAILED HUMAN FACTORS OBSERVATIONS

ERICSSON: DETAILED OBSERVATIONS

The following observations derive from two sources: (a) written comments of the 12 soldiers trained to operate the Ericsson radio; (b) the findings of two human-factors specialists who independently assessed the operator-radio interface characteristics of the radio. The "comments" and "possible improvements" are offered as suggestions only. They are not necessarily exhaustive, sufficient, consistent, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine. The human factors evaluation of this radio was impeded slightly because of the lack of an adequate operator's manual.

Section 1: Operator's Manual

1.01 **OBSERVATION:** On a scale from -100 (poor) to +100 (good), the Ericsson manual was given the following scores by the reviewers (two human-factors specialists): Content (-75); Readability (+8); Illustration (-100); Durability (-100). An overall mean of -62 was obtained by weighting the four content areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean indicated that the manual was evaluated negatively in most respects. Areas receiving negative evaluations were the following: table of contents, general overview, operating instructions, maintenance instructions, troubleshooting, specifications, subject index, safety hazards, type size, spacing, reading level, margins, emphasis, number of illustrations, proximity of illustrations, clarity of illustrations, quality of pictures, and durability. The manual provided would thus be inadequate in almost all respects.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly. (It is assumed that most of the official documentation associated with the Ericsson radio is in the Swedish language. The so-called "Operator's Manual" supplied for the assessment was a 20-page photocopy of a typewritten document that was obviously not the official manual. It was apparently put together in a hurry in order to supply American instructors and students with some sort of documentation in the English language; and it is assumed that a better manual would be supplied if requested.)

1.02 **OBSERVATION:** Some operators commented that the manual was scarcely used during their training. Others noted the absence of illustrations, index, etc. Others noted that their learning from the hands-on training was adequate without the manual.

IMPACT: The absence of an effective operator's manual can affect the "trainability" and "operability" of a system. Although there was little indication that the "manual" supplied with this radio constituted a serious drawback for the purposes of the operational assessment, it was, indeed, one of the six general areas considered in estimating the trainability of the system.

COMMENTS/POSSIBLE IMPROVEMENTS: A well-written and illustrated manual can be a valuable training and field asset for many soldiers.

Section 2: Operating Controls

2.01 **OBSERVATION:** The front panel controls (including the keyboard) are not illuminated for use in low-light or no-light situations. Operators appear to view this as a significant problem.

IMPACT: The lack of panel lighting makes it difficult or impossible for operators to manipulate the controls effectively in the dark without some sort of external light source, such as a flashlight, which may constitute a breach of security.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide back- or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

2.02 **OBSERVATION:** The control knobs are attached by screws with common straight-slotted heads.

IMPACT: The knobs would be very easy for maintenance personnel to remove; the disadvantage of this is that they would also be very easy for the operator or others to remove.

COMMENTS/POSSIBLE IMPROVEMENTS: The question arises how well will the screws work? Will they loosen during transportation or movement of the vehicles in which the radios are mounted? The answers were not determined during the assessment. Consider changing to two captive set screws spaced 90 degrees apart on the side of the knob.

2.03 **OBSERVATION:** There were several operator comments indicating that the knobs turn too easily or that there may be too much "play" in the knobs. One comment specified that the detents between settings were too "soft." (See Observation 2.04.)

IMPACT: The knob pointers may not accurately indicate the knob position. Switches may be changed inadvertently.

COMMENTS/POSSIBLE IMPROVEMENTS: Knob design and performance should be examined carefully to ensure that there is no free shaft rotation and that detents provide appropriate resistance.

2.04 **OBSERVATION:** On at least one of the radios in the assessment, the net selector knob would not click into position properly and tended to slip out of its setting. One operator reported having to push in on the knob while turning it in order to get it to work properly. (See Observation 2.03.)

IMPACT: Knobs that do not work properly may interfere with mission accomplishment.

COMMENTS/POSSIBLE IMPROVEMENTS: The engineering design of the rotary selector switches on the radio should be examined to determine if they need improvements in order to stand up to the rigorous treatment they would sustain in the field environment.

2.05 **OBSERVATION:** One operator reported that the MODE switch was not working properly: "The MODE switch [does] not [change] when you turn it once in a while."

IMPACT: Degraded communication capability.

COMMENTS/POSSIBLE IMPROVEMENTS: The operator's comment did not make the nature of the problem clear. Whether the problem was in the switch itself, or the radio's response to the switch is unclear.

2.06 **OBSERVATION:** The shape of the control knobs is symmetrical.

IMPACT: The shape does not provide unambiguous indication of switch settings, especially in low-light or dark or from side angles of view. It is difficult to impossible to read the positions of the NET and VOLUME switches from side angles.

COMMENTS/POSSIBLE IMPROVEMENTS: Use knobs that point, irrespective of any reference markings they may possess. The shape should minimize parallax distortion (normally achieved by sloping the pointer toward reference marks on the face of the panel). Conform to the design specifications in MIL-STD-1472C.

2.07 **OBSERVATION:** The "ERASE" position of the MODE switch does not provide sufficient tactile feedback. The switch does not actually move into the area marked "ERASE."

IMPACT: The operator may be unsure that erasure has been accomplished and may feel that there is something wrong with the switch.

COMMENTS/POSSIBLE IMPROVEMENTS: If the "emergency reset" procedure (see Observation 6.03) is to be retained, the MODE switch needs to be re-designed to allow the pointer to move into the "ERASE" area.

2.08 **OBSERVATION:** Several operator complaints attested to fact that the force required to activate the keyboard buttons is too great. For example, one operator wrote: "When depressing the keypad button, you have to press real hard. They need to be easier."

IMPACT: The force required is sufficient to slide an unsecured radio across a smooth, flat surface. This might present a problem for the backpack configuration, when the operator sets the radio on a smooth, sloping surface such as a rock or a vehicle body. The problem may be

aggravated by the fact that it is frequently necessary to press two keys at the same time, which does not leave one hand free to steady the radio (see Observation 6.01). The problem may also make it more difficult to operate the keys with gloves on. (Examples of operator comments: [a] "Hard to push button with gloves [while] programming"; [b] "While wearing gloves, I found the keys hard to punch; could become a factor in cold weather"; [c] "Keypad can't be operated with gloves on.") Furthermore, the excessive force may contribute to premature wear on the key surface, which consists of a soft, rubber-like substance. (One operator commented: "After a while, your fingernail would wear a hole in the rubber--could be a little harder.") Because the keys are so hard to push, it is tempting to use an instrument of some sort, such as a pencil, rather than the finger, which, with prolonged use, might be damaging to the key. The problem may also make it necessary for the operator to make a second attempt to activate a desired function simply because the button or buttons were not pressed hard enough the first time. (One operator stated: "While programming the radio, sometimes you can push the keys to load in the groups, but at times it didn't respond the first time." Another said: ". . . pressing two keys at the same time usually had to be done more than twice to get a response.")

COMMENTS/POSSIBLE IMPROVEMENTS: Decrease the force required to activate the keyboard buttons, ensuring that positive tactile feedback indicates when the switch contact has been made. (Ref. MIL-STD-1472C, par. 5.4.3.1.3.)

2.09 **OBSERVATION:** One operator noted the desirability of having a "clear entry" key on the keyboard: "A key that would correct mistakes would be . . . helpful, especially [when] filling in groups one through eight."

IMPACT: The same operator noted: "When you made a mistake, you had to start all over again; [it is] time consuming to start all over."

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a way to correct the last entry without having to erase several previous entries.

2.10 **OBSERVATION:** The handset pressel ("push-to-talk" switch) does not provide sufficient tactile feedback (see also Observations 2.11 & 2.12.)

IMPACT: The operator is not able to determine easily by feel when the switch contacts are made or broken. This is probably compensated for by the operator's exerting an inordinate amount of pressure on the switch to ensure that the contact is made. If the switch must be maintained in the closed position for long periods of time or used frequently, the task of operating the switch can be quite fatiguing to the hand.

COMMENTS/POSSIBLE IMPROVEMENTS: Redesign the switch to provide positive feedback.

2.11 **OBSERVATION:** The handset pressel may be unnecessarily difficult to depress. Operator comments: (a) "Handset keys too hard"; (b) "The handset is very difficult to push."

IMPACT: Hand fatigue may occur during periods of frequent or prolonged communications.

COMMENTS/POSSIBLE IMPROVEMENTS: The pressel should be easy enough to depress so that frequent or prolonged communications will not tire the hand, but resistant enough to prevent accidental tripping of the pressel switch.

2.12 **OBSERVATION:** The rubber-like cover on the handset pressel deflects sideways when the pressel is activated.

IMPACT: The spongy feeling that results from the deflection contributes to the lack of tactile feedback (see Observation 2.10).

COMMENTS/POSSIBLE IMPROVEMENTS: The pressel should be redesigned to provide an unambiguous tactile response.

2.13 **OBSERVATION:** The handset pressel is on the side of the handset.

IMPACT: The switch is vulnerable to impact, wear (etc.) in addition to being more difficult for left-handed operators to use.

COMMENTS/POSSIBLE IMPROVEMENTS: Put the switch on the inside of the handle.

Section 3: Display

3.01 **OBSERVATION:** The edges of the display can be read from a maximum of approximately 25 degrees above, 23 degrees below, 18 degrees to the left, and 21 degrees to the right.

IMPACT: It is impossible to read the edges of the display from operating positions outside the described perimeter. Near the edges of this perimeter it is possible to misinterpret characters. One operator noted: "At some angles the display can't fully be seen without changing positions."

COMMENTS/POSSIBLE IMPROVEMENTS: Increase viewing angles from all sides. Ideally, the display would allow viewing from about 45 degrees in all directions. (The visual accessibility of the display from a straight-on perspective is excellent; and the versatile, 13-segment, green LED characters provide detailed operational feedback to the operator.)

3.02 **OBSERVATION:** Several operators reported that the display was difficult to read in sunlight or from side angles, which are prone to glare.

IMPACT: Difficulty in seeing the display could significantly prolong programming and other operational procedures and increase the likelihood of errors.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide awnings (or equivalent) to help shade the display or otherwise reduce glare.

3.03 **OBSERVATION:** The display automatically switches off about five seconds after the last input.

IMPACT: While this feature is desirable in most situations, it becomes an annoyance to operators during programming procedures. If the operator pauses for five seconds during the process, the display turns off and it becomes necessary to start the programming over from the beginning.

COMMENTS/POSSIBLE IMPROVEMENTS: Perhaps an automatic or manual override could be built into the programming process so that the display would stay on for a longer period or until the programming has been completed.

3.04 **OBSERVATION:** The following miscellaneous comments pertaining to the display were made by one or more operators: (a) "The window needs to be a little bigger"; (b) "Display lasts too long"; (c) "Reaction time could be quicker."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

Section 4: Labels

4.01 **OBSERVATION:** The so-called "RETURN" key is used for a multitude of purposes for which the key is not labeled (entering, ending, showing status, turning display off, changing states, calculating, clearing display, etc). None of the uses pertains to the graphic label on the key, which is an anachronistic holdover from the old-fashioned typewriter (see also Observation 4.02).

IMPACT: Use of the return key is confusing and may constitute an operational or training stumbling block.

COMMENTS/POSSIBLE IMPROVEMENTS: All controls should be adequately labeled for their functions and there should be no function that has no associated label. The RETURN key is overworked. Perhaps some of its functions could be transferred as alternate functions to other keys.

4.02 **OBSERVATION:** The label on the SHIFT key (an upward pointing arrow) is, like the label on the RETURN key, an old-fashioned holdover from the typewriter (see Observation 4.01). It does not signify in a literal sense the functions of the key.

IMPACT: The purpose of the key must be learned and remembered without assistance from the label.

COMMENTS/POSSIBLE IMPROVEMENTS: Change the label to "SHIFT," "2nd FCTN" (second function), "ALT FCTN" (alternate function), or other informative label (see also Observation 4.08, Impact).

4.03 **OBSERVATION:** The "9" key is used to check the time variable. The key is not so labeled.

IMPACT: An extra cognitive burden in placed on the trainee and operator who are forced to remember which key is used for this purpose.

COMMENTS/POSSIBLE IMPROVEMENTS: Label the key. The word "TIME" should appear over the key as an alternate function.

4.04 **OBSERVATION:** The "0" and "1" keys are used to indicate "no" and "yes," respectively, during programming. They are not so labeled.

IMPACT: As for Observation 4.03, an unnecessary memory burden is placed upon trainees and operators.

COMMENTS/POSSIBLE IMPROVEMENTS: Label the keys.

4.05 **OBSERVATION:** The intercom function (which like many others, requires two hands--see Observation 2.08, Impact & Observation 6.01) is not indicated by a label on the radio.

IMPACT: The operator must remember the procedure for using the intercom feature with no prompt--an unnecessary burden.

COMMENTS/POSSIBLE IMPROVEMENTS: Perhaps this function could be transferred from the SHIFT key to another key as an alternate function.

4.06 **OBSERVATION:** The label "TRANSMIT" over the "3" key is misleading. It does not mean "transmit" in its general sense; rather it refers only to data transmissions in particular.

IMPACT: Remembering the procedure for transmitting data bursts would be more difficult than necessary, especially for the trainee.

COMMENTS/POSSIBLE IMPROVEMENTS: Change the label to something like "DATA XMT," or "DATA TRANS."

4.07 **OBSERVATION:** The "AUTO" in the label "AUTORETR" is unnecessary.

IMPACT: "AUTO" takes up space that could be used to make the label more meaningful.

COMMENTS/POSSIBLE IMPROVEMENTS: Change the label to "DATA RE-XMT," "DATA RETRANS," or the like.

4.08 **OBSERVATION:** The "DIM" and "TEST" labels are located underneath their respective keys, whereas all other alternate functions are labeled above their respective keys.

IMPACT: An unnecessary inconsistency, compounded by the upward-pointing arrow on the SHIFT key (see Observation 4.02).

COMMENTS/POSSIBLE IMPROVEMENTS: Place the labels above the keys.

4.09 **OBSERVATION:** The "DIM" and "TEST" labels are red, unlike the other alternate-function labels, which are white.

IMPACT: The red color, combined with the position of the labels (see Observation 4.08), makes them more difficult to read than the white labels, especially in low-light situations.

COMMENTS/POSSIBLE IMPROVEMENTS: Change the color to white.

4.10 **OBSERVATION:** There is a horizontal red dash to the left of the SHIFT key. Its meaning is not apparent, nor is it discussed in the manual provided.

IMPACT: An unnecessary obscurity.

COMMENTS/POSSIBLE IMPROVEMENTS: Clarify. (Does it belong to the reference line for the "ERASE" label?)

Section 5: Connectors

5.01 **OBSERVATION:** Connectors are not provided with protective caps.

IMPACT: The connectors can collect water and debris and are exposed to physical abuse.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide caps that are integral to the connectors and that do not interfere with operating or maintaining the radio when they are not in use.

5.02 **OBSERVATION:** There is little room for the fingers when installing the backpack antenna/handle connector.

IMPACT: The installation is more difficult and time consuming than is desirable.

COMMENTS/POSSIBLE IMPROVEMENTS: Redesign to allow more room.

5.03 **OBSERVATION:** The screw on the backpack antenna connector is easily removable, but it is not captive.

IMPACT: It can be easily lost.

COMMENTS/POSSIBLE IMPROVEMENTS: Use a captive screw.

5.04 **OBSERVATION:** The backpack antenna/handle connector is attached by screws.

IMPACT: Installation requires a tool (screwdriver, or equivalent) and is thus a burdensome, awkward, and time-consuming procedure.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide an easier, quicker method that does not rely on a tool.

5.05 **OBSERVATION:** The handset connector has no alignment coding; the human-factors specialists found the handset easy to connect despite the lack of coding. One operator, however, complained that the handset was difficult to connect.

IMPACT: Possible operational delay.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide coding that indicates the proper orientation of the connector.

5.06 **OBSERVATION:** Two operator observations indicated that the antenna and/or antenna connector may have a tendency to come loose.

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Modification of the antenna connection design might be appropriate.

Section 6: Operational Procedures

6.01 **OBSERVATION:** Many of the operators complained that it is frequently necessary to depress two keys on the keyboard at the same time in order to activate the desired function (e.g., see Observations 6.02 & 6.03). Often this cannot be accomplished easily with one hand. Examples of operator comments: (a) "This display shows only when pushed in sequence with other keys"; (b) "Difficult to push two buttons at a time"; (c) "You always have to push more than once . . . when you have to push two keys at one time" (see Observation 2.08, Impact); (d) "Difficulty in pressing two buttons at a time . . . almost impossible for operation while in 'manpack'--carrier has trouble seeing and reaching"; (e) "It would be a lot easier if you could push one button instead of two."

IMPACT: This is a significant operational handicap. The requirement to press two keys at once introduces awkwardness into the procedures and is time-consuming. There may be times when the operator does not have a "spare hand" to work with. The problem is magnified by the fact that the keys are hard to depress (see Observation 2.08).

COMMENTS/POSSIBLE IMPROVEMENTS: The shift key could be modified to operate like a alternate-function key on a calculator. I.e., it would be pressed prior to selecting the alternate function of another key, but it would not have to be held down while the second key is pressed.

6.02 **OBSERVATION:** To adjust the brightness of the display, the SHIFT and DIM keys must be pressed at the same time; the DIM key must then be held while the brightness cycles through three discrete levels; the key is released when the desired level is exhibited.

IMPACT: Adjusting the brightness level of the display is extremely awkward and time-consuming.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide an alternate method of accomplishing this adjustment. A small brightness control knob that provided a continuum of brightness levels would be a considerable improvement.

6.03 **OBSERVATION:** The emergency "reset" (erase) procedure requires the use of two hands (see Observation 6.01).

IMPACT: Under certain emergency circumstances, this could be a significant handicap. Security may be threatened or valuable time lost.

COMMENTS/POSSIBLE IMPROVEMENTS: The ability to erase net data in an emergency should not be dependent upon the operator's having two hands free to work with. Redesign the procedure so that it requires only one hand and can be accomplished very rapidly..

6.04 **OBSERVATION:** Operators must remember how to initiate too many procedures without prompts. For example, when answering a call in plain from the secure mode, the operator must press the so-called RETURN key before switching the MODE switch to PLAIN. (See Observation 4.01.)

IMPACT: Operational knowledge of the radio is made more difficult to acquire and retain.

COMMENTS/POSSIBLE IMPROVEMENTS: The use of a particular key for a particular purpose should be patently logical from the operator's perspective. This is not true of some of the keys on the keypad. Furthermore, every procedure should be associated with an initiating machine prompt of some sort (label or display message) so that the operator is not required to perform operations by rote. (See Observations 4.01-4.04, 4.06.)

6.05 **OBSERVATION:** Synchronization procedures may be confusing to operators. As described in the makeshift manual provided with the radio, when SHIFT and SYNC are pressed simultaneously to initiate the synchronization procedure, the display may show either "SYNC" or "NO SYNC." According to the manual, the operator's apparent objective at this point is to ensure that the display reads "NO SYNC" (rather than "SYNC") before pressing the RETURN key, which turns off the display. It would seem

likely, however, that the intuitive cognitive response would be to produce "SYNC" in the display (rather than "NO SYNC"). In another place, the manual states that "SYNC" means that the radio is synchronized.

IMPACT: Operators may have difficulty synchronizing their radios. (Two comments from operators complained that it was difficult to synchronize time with the net control station.)

COMMENTS/POSSIBLE IMPROVEMENTS: Whether the operators' difficulty was due to the confusing aspect of the procedure or to another cause is not known. The display messages should be reviewed for appropriateness. (It may be that they are, indeed, appropriate, but that the procedural description in the manual needs clarification.)

Section 7: Communication

7.01 **OBSERVATION:** Operators complained of a variety of noises: (a) "When using a CUC, there is a loud beeping noise which is irritating"; (b) "In [the] exercise yesterday I found static in my radio in secure mode only"; (c) "When ECC is turned [on] after the synchronization sound goes off, there is a gurgling sound . . . and it doesn't go away even if you key the handset for a long time"; (d) "When M60 was running, static was heard in the [radio], but not bad enough to block voice transmission."

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.02 **OBSERVATION:** Three operator comments implied that the quality of communication was inconsistent or better in "plain" than in "secure": (a) "Very inconsistent--stations don't move or change program, and they just lose contact with other stations"; (b) "The radio will not transmit [well] in the secure mode . . . . We can talk to all [stations] in the plain mode only. We can hear all [stations] in the secure mode too"; (c) "We had one station that at times couldn't be heard by any other station but [ours] while in frequency hopping [mode], and sometimes we only got static from them."

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

Section 8: Backpack Configuration

8.01 **OBSERVATION:** A very prevalent complaint pertaining to the backpack configuration of the radio was that the batteries do not last long enough.

IMPACT: Operators must carry additional batteries and change them frequently when "traffic" is heavy.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

8.02 OBSERVATION: One operator stated that the clips on the backpack battery are too difficult to operate.

IMPACT: Combined with the necessity of changing batteries frequently (see Observation 8.01, Impact), this problem may be significant. Communication may be interrupted for unnecessarily long periods of time while batteries are being changed.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the battery clips are easy to manipulate.

8.03 OBSERVATION: One operator noted that the backpack radio was not completely compatible with the rucksack.

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: The exact nature of the problem was not determined.

Section 9: Miscellaneous

9.01 OBSERVATION: A 5-second series of 15 tones is presented in the handset once in every 30-second interval while in the plain mode (their purpose is not explained in the manual provided; presumably they constitute a warning to operators that communication is in the plain mode). In addition, other tones are used at other times. There were many complaints about the prevalence of these tones. Sample operator comments: (a) "Too many beeps--one for plain, another for secure"; (b) "[While] sending . . . DMD messages, [the] tone is very annoying!"; (c) "When keying handset, [one] shouldn't have to hear 20 beeps before you can talk"; (d) "Sometimes when you have been working the radio for a while, the beep in the handset becomes a little annoying." (See also Observation 9.02.)

IMPACT: Operator annoyance.

COMMENTS/POSSIBLE IMPROVEMENTS: Reevaluate the necessity for the tones. Eliminate those not needed for conveying important information and minimize the remaining.

9.02 OBSERVATION: Some of the tones presented in the handset may be too loud: Operator comments: (a) "[They are] too loud--can hear [them] out[side] of vehicles"; (b) "Some of the signals seem a bit loud; could give one's position away."

IMPACT: A possible breach of security.

COMMENTS/POSSIBLE IMPROVEMENTS: Minimize the volume and the number of unnecessary tones (see Observation 9.01).

9.03 **OBSERVATION:** The clip on the handset may be too small.

IMPACT: Especially in the backpack configuration, the handset may not be well retained in its stowed position.

COMMENTS/POSSIBLE IMPROVEMENTS: Consider enlarging the clip.

9.04 **OBSERVATION:** Two operator comments indicated a desire for built-in speakers.

IMPACT: Built-in speakers would eliminate the need for external speakers in most situations and thus simplify installation procedures. They would also insure compatibility of speakers and eliminate the requirement for operators to rely on handset speakers when external speakers are unavailable.

COMMENTS/POSSIBLE IMPROVEMENTS: The feasibility of incorporating built-in speakers into the limited space available is unknown.

9.05 **OBSERVATION:** The radio has no integral carrying handle (although the backpack configuration utilizes a screw-on handle).

IMPACT: The absence of a handle not only makes the radio cumbersome for maintenance personnel and others to carry, it also makes the radio difficult to secure against theft.

COMMENTS/POSSIBLE IMPROVEMENTS: A handle of appropriate design would allow the radio to be chained to its vehicle. A better solution might incorporate antitheft mounts, so that removal could be accomplished easily only by authorized personnel.

HARRIS: DETAILED OBSERVATIONS

The following observations derive from two sources: (a) written comments of the 12 soldiers trained to operate the Harris radio; (b) the findings of two human-factors specialists who independently assessed the operator-radio interface characteristics of the radio. The "comments" and "possible improvements" are offered as suggestions only. They are not necessarily exhaustive, sufficient, consistent, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine.

Section 1: Operator's Manual

1.01 **OBSERVATION:** On a scale from -100 (poor) to +100 (good), the Harris manual was given the following scores by the reviewers (two human-factors specialists): Content (-6); Readability (+71); Illustration (+88); Durability (+100). An overall mean of +51 was obtained by weighting the four areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean indicated that the manual was considered adequate in most respects. Areas receiving negative evaluations were the following: general overview, maintenance instructions, trouble-shooting, subject index, safety hazards, and spacing.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

Section 2: Operating Controls

2.01 **OBSERVATION:** Toggle switches are used to set frequencies.

IMPACT: There is a tendency to overshoot (or undershoot) the desired frequency, which tends to make the operation a little awkward and time consuming.

COMMENTS/POSSIBLE IMPROVEMENTS: Use a keyboard with large keys to provide a simpler, faster means of entering frequencies.

2.02 **OBSERVATION:** The toggle switches are small and appear to be fragile.

IMPACT: The extent to which operators would experience unnecessary difficulty operating these controls under some circumstances (with gloves, from awkward positions, etc.) is unknown. The switches may be prone to physical damage.

COMMENTS/POSSIBLE IMPROVEMENTS: Use larger switches.

2.03 **OBSERVATION:** The soft, rubber-like coverings on the toggle switches are loose fitting and appear to be flimsy.

IMPACT: In their written comments, the operators expressed a dislike for the toggle switch covers and felt that they would not last long in an operational environment. The looseness of the rubber detracts from the "positive feel" of the switches.

COMMENTS/POSSIBLE IMPROVEMENTS: Use of a larger switch would lessen the need for covers on the switches. Covers, if desirable, should be firm and damage resistant.

2.04 **OBSERVATION:** The control knobs appear to lack durability.

IMPACT: The knobs may be prone to physical damage. (One operator reported that when his radio was struck with a steel helmet, one or more of the knob shafts bent. The operator reported he was able to bend them back into their proper orientation.)

COMMENTS/POSSIBLE IMPROVEMENTS: Use heavier control knobs.

2.05 **OBSERVATION:** One operator complained of a loose knob that tended to rotate (to an unknown degree) on its shaft.

IMPACT: Unknown. Possibly a quality control or design problem.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the mechanism for attaching knobs to their shafts is sturdy and reliable. Ensure that the shaft or switch does not contribute to the problem.

2.06 **OBSERVATION:** The "OFF" detent on the "VOLUME" knob was weak.

IMPACT: The radio may be accidentally turned off while manipulating the volume.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase the resistance of the detent to make the "OFF" position easily distinguishable by feel from all other positions of the switch. Provide an interlock at the "OFF" position.

2.07 **OBSERVATION:** The detent on the whisper mode position of the display light switch was weak.

IMPACT: The operator may accidentally go into the whisper mode while manipulating display brightness.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase the resistance of the detent to make the whisper mode easily distinguishable by feel from all other positions of the switch. Provide an interlock at the "WSPR" position.

2.08 **OBSERVATION:** The shape of the control knobs (display, volume, channel, mode, and power) is symmetrical.

IMPACT: The shape provides ambiguous indication of switch settings, especially in low-light or dark, or from side angles of view.

COMMENTS/POSSIBLE IMPROVEMENTS: Use knobs that point, irrespective of any reference markings they may possess. The shape should minimize parallax distortion (normally achieved by sloping pointer toward reference marks on panel face). Conform to the design specifications presented in MIL-STD-1472C.

2.09 **OBSERVATION:** The "TEST/LOAD" button is located too close to the antenna jack.

IMPACT: Safety hazard. The operator may touch the antenna while pushing the self-test button. This exposes the operator to a possible RF burn. (Two instances were reported during the assessment period. There may have been others that were not reported.)

COMMENTS/POSSIBLE IMPROVEMENTS: Remove the "TEST/LOAD" button from the proximity of the antenna jack.

2.10 **OBSERVATION:** The front panel controls are not illuminated for use in low-light or no-light situations. Operators appear to view this as a significant problem.

IMPACT: The lack of panel lighting makes it difficult or impossible to manipulate the controls effectively in the dark without some sort of external light source, such as a flashlight, which may breach security.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide back- or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

Section 3: Display

3.01 **OBSERVATION:** The edges of the display can be read from a maximum of approximately 37 degrees above, 41 degrees below, and 23 degrees to either side.

IMPACT: Impossible to read edges of display from operating positions outside the described perimeter. It is possible to misinterpret characters, especially at the ends of the display.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase viewing angles from both sides. Ideally, the display would allow viewing from about 45 degrees in all directions.

3.02 **OBSERVATION:** One operator noted that the display light was on continuously after the third day of the field exercise.

IMPACT: Frequency was continuously displayed. Possible switch problem.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

3.03 **OBSERVATION:** One operator noted that the display tends to collect dust and hold dirt in the corners.

IMPACT: Reduced readability of display.

COMMENTS/POSSIBLE IMPROVEMENTS: Make display window flush with panel or slope display borders to minimize tendency to retain debris.

3.04 **OBSERVATION:** The LED display is red.

IMPACT: When a red ambient light is used during light-discipline situations, the visibility of the display may be degraded significantly. The display may also tend to wash out in bright sunlight.

COMMENTS/POSSIBLE IMPROVEMENTS: Replace with a blue-green LED.

3.05 **OBSERVATION:** Operators complained that the display does not stay on long enough.

IMPACT: Operators must repeatedly press the display button to energize the LED.

COMMENTS/POSSIBLE IMPROVEMENTS: Allow the display to stay on for a longer duration.

3.06 **OBSERVATION:** After the radio passes the self-test, the display shows the battery voltage and then blanks out.

IMPACT: No salient indication is provided to the operator that the radio has passed the self-test. The operator is forced to recall that the <u>absence</u> of an indication implies that the self-test was passed.

COMMENTS/POSSIBLE IMPROVEMENTS: Require display to provide positive feedback to the operator--such as "PASS" or other appropriate term.

3.07 **OBSERVATION:** When the radio is turned on, neither the "OFF/VOLUME" switch nor the display indicates that a battery check has occurred. The voltage number shown in the display is not identified.

IMPACT: The new operator must learn and remember that the number refers to battery voltage.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide display indication that the number refers to battery voltage. This could be accomplished in several ways: "12V," "b12," etc. (However, see Observation 3.08.)

3.08 **OBSERVATION:** The LED is composed of five seven-element digits.

IMPACT: The display is severely limited in the extent to which meaningful prompts and feedback can be presented to the operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Incorporate a more versatile display.

Section 4: Labels

4.01 **OBSERVATION:** The radio identification label is located on the front panel.

IMPACT: This label has no operational function; it adds unnecessary clutter to the front panel and uses space that could possibly be better utilized.

COMMENTS/POSSIBLE IMPROVEMENTS: Eliminate or relocate the label.

4.02 **OBSERVATION:** The label "MANUAL," located above the channel selector, is a misnomer. This term implies that the so-called "manual" channel is, unlike the other channels, somehow nonautomatic (i.e., operated manually). This distinction appears to be superfluous, having no bearing on the operating features of any of the channels.

IMPACT: Although the term is widely used, both new and seasoned operators tend to be confused about the purpose, proper usage, and nature of so-called "manual" channels.

COMMENTS/POSSIBLE IMPROVEMENTS: Replace the term with an appropriate and informative designator that connotes the administrative (or other) nature of the channel.

4.03 **OBSERVATION:** The label "MANUAL" above the channel selector gives the appearance of being the name of the selector rather than of a single position on the selector.

IMPACT: The purpose of the control may be misconstrued by the trainee or inexperienced operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Shorten the label to "MAN" or "M" (but see Observation 4.02) and locate as the other channel designators are located.

4.04 **OBSERVATION:** The arrangement of channels on the channel selector is non-standard (channel numbers increase from right to left rather than vice versa).

IMPACT: Minor conflict with commonly learned human response patterns.

COMMENTS/POSSIBLE IMPROVEMENTS: Start series with "1" at the current "5" position and switch the "manual" position to the current "4" position. (But see also Observation 4.02.)

4.05 **OBSERVATION:** The "OFF/VOLUME" control has no detents.

IMPACT: The reference "dots" around the control knob serve no useful purpose.

COMMENTS/POSSIBLE IMPROVEMENTS: A more useful referent might be a crescent scale to indicate increasing volume as the control is rotated clockwise. Alternatively, detents could be incorporated into the switch so that the reference dots would be meaningful.

4.06 **OBSERVATION:** The "DISPLAY DIM" control has no detents.

IMPACT: The reference "dots" around the control knob serve no useful purpose.

COMMENTS/POSSIBLE IMPROVEMENTS: A more useful referent might be a crescent scale to indicate increasing brightness as the control is rotated clockwise. Alternatively, detents could be incorporated into the switch so that the reference dots would be meaningful.

Section 5: Connectors and Cables

5.01 **OBSERVATION:** Operators complained about the number of cables involved in the vehicular configuration (radio, adapter unit, and power amplifier).

IMPACT: The protruding array of cables interferes with operation of the radio controls. The array of cables may be confusing to new operators. The situation is not conducive to rapid installation or disassembly. Other equipment may get tangled in the cables. Possible safety hazard.

COMMENTS/POSSIBLE IMPROVEMENTS: Relocate connectors. Use different kinds of connectors (L-shaped, etc.). Eliminate redundancy with connectors on the face of the radio itself. Integrate certain connections (e.g., power) with installation of the adapter unit. Permanently attach short cables to the RF-in and RF-out connectors on the power amplifier.

5.02 **OBSERVATION:** Connector plugs and sockets are not conspicuously coded for easy alignment.

IMPACT: Making connections is unnecessarily time-consuming and often a matter of trial and error.

COMMENTS/POSSIBLE IMPROVEMENTS: Employ shape and/or color coding on connectors.

5.03. **OBSERVATION:** The connectors on the front of the radio are close to the carrying handles.

IMPACT: One operator commented that the carrying handles interfered with inserting the audio plug. The difficulty may extend to the other connectors as well.

COMMENTS/POSSIBLE IMPROVEMENTS: Maximize the distance between connectors and physical obstructions.

5.04 **OBSERVATION:** The protective cap for the backpack antenna connector is awkward to install and remove. It must be screwed on, and the retaining cord for the cap tends to interfere--it winds up as the cap is turned.

IMPACT: Operator frustration and wasted time.

COMMENTS/POSSIBLE IMPROVEMENTS: Use a different kind of cap that does not require turning--perhaps a plug.

5.05 **OBSERVATION:** The backpack battery connector pins are not well protected.

IMPACT: The pins, located at one end of the battery, are subject to damage when the battery is lifted at the opposite end.

COMMENTS/POSSIBLE IMPROVEMENTS: Redesign battery housing or connector so that the battery cannot be removed improperly.

Section 6: Operational Procedures

6.01 **OBSERVATION:** Checking frequencies is a two-step process.

IMPACT: Prior to selecting the desired channel, the mode switch must be set to "PRGRM" (program), which, from the operator's perspective, may not be logical (there is no intention to "program" when frequencies are being checked). This procedure may be unnecessarily complicated and time-consuming. It places additional learning and retention requirements on the operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Allow frequency check by manipulating channel selector only (feasibility unknown).

6.02 **OBSERVATION:** The procedure for setting the half-duplex transmit frequency is cumbersome. It requires two hands--one to activate and hold the P-T-T switch, another to activate the display and enter the frequency.

IMPACT: An inconvenience, possibly significant in some situations.

COMMENTS/POSSIBLE IMPROVEMENTS: Eliminate the need to hold the P-T-T switch.

6.03 **OBSERVATION:** One operator noted that control of volume from the front panel was lost when the VINSON (KY-57) equipment was connected.

IMPACT: Operating procedures are changed, which increases the learning and retention burden on the operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, the control of an operating variable such as volume should be not be altered by the addition of ancillary equipment. If feasible, return control of volume to the front panel of the radio.

6.04 **OBSERVATION:** The mode switch, when set to "PRGRM" (program), produces a constant tone.

IMPACT: The tone is annoying to operators and constitutes a possible breach of security in noise-discipline situations.

COMMENTS/POSSIBLE IMPROVEMENTS: Eliminate the tone, if feasible.

Section 7: Communication

7.01 **OBSERVATION:** The operators made many comments indicating that the radio was not adequately compatible with the VINSON (KY-57) equipment.

IMPACT: Excessive static or distortion or a total inability to communicate. Sometimes operators could receive but not transmit. Potentially serious mission/security hazard.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.02 **OBSERVATION:** Many operator comments indicated that disrupting static, noise, or tones could be heard in the handset when the vehicle engines were running. Track, tank, and "jeep" vehicles were all mentioned.

IMPACT: Degradation of communication. In general, considered "moderate" problem by operators.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.03 **OBSERVATION:** Several operators complained of static from unspecified sources.

IMPACT: Degradation of communication. Possibly connected with use of VINSON (KY-57) equipment or vehicle engines.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

Section 8: Backpack Configuration

8.01 **OBSERVATION:** Low battery voltage is signaled by a recurring "beep."

IMPACT: An annoyance to operators and a possible security hazard. One operator commented, "the 'beeping' every 5 seconds could give a position away."

COMMENTS/POSSIBLE IMPROVEMENTS: Substitute another method for warning the operator of low battery voltage--perhaps an LED signal strength indicator.

8.02 **OBSERVATION:** Operators complained that the backpack configuration in combination with the VINSON (KY-57) was bulky and cumbersome, and that the available straps were too short to attach the VINSON to the radio.

IMPACT: Operators were required to use a non-standard method of securing the VINSON to the radio. They noted a tendency to lose balance because of the load distribution.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide suitable straps or other adequate method of assembling the VINSON into the backpack configuration.

8.03 **OBSERVATION:** One operator noted that the pack needed to "be of a softer material."

IMPACT: Discomfort.

COMMENTS/POSSIBLE IMPROVEMENTS: Modify shape, size, or material of pack to maximize comfort.

ITT: DETAILED OBSERVATIONS

The following observations derive from two sources: (a) written comments of the 12 soldiers trained to operate the ITT radio; (b) the findings of two human-factors specialists who independently assessed the operator-radio interface characteristics of the radio. The "comments" and "possible improvements" are offered as suggestions only. They are not exhaustive (the reader is referred to earlier human factors reports on the ITT SINCGARS; see References). They are also not necessarily sufficient, consistent, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine.

Section 1: Operator's Manual

1.01 **OBSERVATION:** On a scale from -100 (poor) to +100 (good), the ITT Operator's Manual (TM 11-5820-890-10-1) was given the following scores by the reviewers (two human-factors specialists): Content (+38); Readability (+15); Illustration (+38); Durability (-50). An overall mean of +16 was obtained by weighting the four areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean, although positive, indicates considerable room for improvement. Areas receiving negative evaluations were: table of contents, general overview, operating instructions, maintenance instructions, spacing, reading level, emphasis, and durability.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

1.02 **OBSERVATION:** The index of the Operator's Manual contains useless, non-keyword entries that are more appropriate to a table of contents. Examples: "Operation in unusual weather" (instead of "Weather"); "Operator's controls, indicators and connectors" (instead of "Controls," "Indicators," and "Connectors" as three separate entries); "Choosing a site for operation" (instead of "Site"); "Components of end item list" (instead of "End item list, components of"); "Daily checks and self-tests" (instead of "Checks and self-tests" and "Self-tests and checks" as separate entries); "Retrieving lockout set or hopset" (instead of "Lockout set, retrieving" and "Hopset, retrieving" as separate entries); "Use of operator's controls, indicators and connectors" (instead of "Controls," "Indicators," and "Connectors" as separate entries).

IMPACT: It is impossible to conveniently locate numerous entries because they are not entered as keywords. One must flip through the manual or scan much of the index to find information--both of which waste considerable amounts of time and contribute to non-usage of the manual.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly. Use keywords only as index entries.

1.03 **OBSERVATION:** The index of the Operator's Manual does not contain a sufficient number of entries. Examples of needed entries: Audio, CEOI, Clear, Cold start, Data transmission, Electronic remote fill, E1, E2, FCTN switch, Fill device, Full-load opening, J5, LD, LD-V, Lithium battery, Local fill, Loudspeaker, MODE switch, NCS, NET, Range, RXMT switch, Sidetone, Specifications, Squelch, Variables, Vehicular, Whisper mode, Z-A.

IMPACT: The operator cannot find desired information in the index and must resort to searching through the manual, which wastes time and discourages use of the manual.

COMMENTS/POSSIBLE IMPROVEMENTS: Expand the index.

1.04 **OBSERVATION:** The glossary of the Operator's Manual, like the index, should contain more entries. Examples: Cold start, Local fill, Full load. (See also Observation 1.05.)

IMPACT: Certain terms with which the operator (especially the trainee) may not be familiar are not concisely or adequately defined. Like the deficiencies in the index, the deficiencies in the glossary make it a feature that, instead of helping the operator, may simply take up space and discourage use of the manual.

COMMENTS/POSSIBLE IMPROVEMENTS: Expand the glossary.

1.05 **OBSERVATION:** The terms "cold start," "full load opening," and "local fill," are ambiguous and may be misleading; the related chart in the Operator's Manual (p. 2-43) is abstruse.

IMPACT: Operators may find it difficult to learn or remember the meaning of the terms. Consequently, start-up procedures may be perceived as more confusing than they really are, or they may be performed less effectively.

COMMENTS/POSSIBLE IMPROVEMENTS: Terms whose meanings are literal are more informative than loose metaphors. The names for procedures or operational states (as well as all other operational terms) should, to the extent possible, immediately assist the trainee in understanding the process or concept involved; ideally they should not themselves constitute additional terms whose meanings must be learned.

1.06 **OBSERVATION:** The Operator's Manual contains instances of illogical, inconsistent, and ill-chosen heading formats. (See Observation 1.07.) One example is provided here. On pages 1-2 and 1-3, "Reference Information" is introduced as follows:

p. 1-2: | REFERENCE INFORMATION |

p. 1-3: | REFERENCE INFORMATION Continued |

On pages 2-10 and 2-11, however, "Special Instructions" is introduced as follows:

p. 2-10: SPECIAL INSTRUCTIONS

p. 2-11: ¦ SPECIAL INSTRUCTIONS Continued ¦

Note the missing box in the latter pair. The continuation of the material is given more emphasis than its introduction.

IMPACT: The logical relation among headings in the manual is obscured, making it unnecessarily difficult to locate and follow information.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that headings are well-chosen and used judiciously.

1.07 **OBSERVATION:** The format of the Operator's Manual is complex, cluttered, and confusingly organized. Often, material that is too detailed or unnecessary is included (e.g., p. 2-23, par. D). The pages are often very "busy" and foreboding. (See Observation 1.06.)

IMPACT: The operator or trainer may forego use of the manual or find it much more difficult to understand and use than is necessary.

COMMENTS/POSSIBLE IMPROVEMENTS: Extensive revision is in order. The manual needs to be shorter, simpler, cleaner, and better organized.

1.08 **OBSERVATION:** The Operator's Manual lacks durability.

IMPACT: As is, the manual is unsuitable for field use. (The new copy presented for review literally began to fall apart during the first few minutes of use.)

COMMENTS/POSSIBLE IMPROVEMENTS: The manual should be able to withstand field use. It should have a much better binding, be waterproof, and easily stowable.

Section 2: Operating Controls

2.01 **OBSERVATION:** The front panel controls (including the keyboard) are not illuminated for use in low-light or no-light situations. Operators appear to view this as a significant problem.

IMPACT: The lack of panel lighting makes it difficult or impossible for operators to manipulate the controls effectively in the dark without some sort of external light source, such as a flashlight, which may constitute a breach of security.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide back- or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

2.02 **OBSERVATION:** The control panel is crowded.

IMPACT: The DATA switch can be troublesome to operate when a cable is attached to the DATA connector. The VOL control can be accidently moved during the manipulation of the data control knob and adjacent controls (see Observation 2.05). The operator's knuckle may scrape against the FILL connector while turning the volume knob. The connectors are very close to the handles. The RF power control is too close to the antenna. In general, minimal clearances cause difficulty in connecting cables and manipulating controls (especially while wearing gloves), which may result in increased operator performance time and frustration.

COMMENTS/POSSIBLE IMPROVEMENTS: No complete solution was identified short of a redesign of the control panel, which might include relegating many functions to an expanded keyboard. However, modifying the design of the rotary selector switches and the VOL control (see Observations 2.03 and 2.05) might decrease the impact of the crowding problem.

2.03 **OBSERVATION:** The shape of the rotary selector knobs (CHAN, RF, MODE, FCTN, and DATA) does not provide unambiguous indication of switch settings, making it difficult to impossible to observe the settings from side angles or in low light.

IMPACT: Operator performance time and error rate may be unnecessarily high.

COMMENTS/POSSIBLE IMPROVEMENTS: Replace the knobs with those conforming to the design requirements of MIL-STD-1472C. Use knobs that point, irrespective of any reference markings they may possess. The shape should minimize parallax distortion (normally achieved by sloping the pointer toward reference marks on the panel face). Reference lines on the knobs would be helpful.

2.04 **OBSERVATION:** The DATA switch is difficult to manipulate because (a) it is too close to the data connector and (b) the finger grip portion of the knob is too short to grasp effectively.

IMPACT: As stated in Observation 2.02, minimal clearances cause general difficulty with connecting cables and manipulating controls, which may result in increased operator performance time and frustration. The problem is compounded if at the same time the knob is difficult to grasp because of its shape.

COMMENTS/POSSIBLE IMPROVEMENTS: Enlarge the finger grip area on the knob. (See also comment for Observation 2.02.)

2.05 **OBSERVATION:** The VOL (volume) control is prone to accidental movement.

IMPACT: Accidental movement to a minimum setting renders reception inaudible. Inadvertent maximum settings could breach noise discipline in tactical situations or hurt the operator's ears. Since the radio may not be receiving signals much of the time, the effect of accidental movement of the volume control may not be immediately apparent. This problem is aggravated by the lack of meaningful level markings (see Observations 4.13 and 4.14) and lack of clearance with other controls (see Observation 2.02.)

COMMENTS/POSSIBLE IMPROVEMENTS: Increase the resistance to movement.

2.06 **OBSERVATION:** The inclusion of the offset function on the SEnd key is illogical since the two functions are not related.

IMPACT: The resulting confusion unnecessarily complicates training and operation. Also, the meaning of the label can be mistaken for "send offset" (see Observation 4.12).

COMMENTS/POSSIBLE IMPROVEMENTS: Move the offset function to the FREQ key, since offset is logically associated with frequency. (But see Observations 4.15 and 4.17.)

2.07 **OBSERVATION:** Tank commanders must duck into the tank from their observation position in order to operate controls on the radio and to view the display. (The frequency with which this situation might occur in a realistic situation was not assessed.)

IMPACT: While operating the radio the commander loses visual contact with his surroundings. The import of this fact was not evaluated.

COMMENTS/POSSIBLE IMPROVEMENTS: Further evaluation of this observation by appropriate experts may be warranted.

2.08 **OBSERVATION:** The "push-to-talk" switch is located on the side of the handset (H-250/U).

IMPACT: The switch is vulnerable to impact, wear (etc.) in addition to being somewhat less convenient for left-handed operators to use.

COMMENTS/POSSIBLE IMPROVEMENTS: Put the switch on the inside of the handle.

2.09 **OBSERVATION:** The "push-to-talk" switch does not have a "positive feel"; i.e., it does not provide sufficient tactile feedback to the operator.

IMPACT: The operator is not able to easily feel when the switch contacts are made or broken. This is probably compensated for by the operator's exerting an inordinate amount of pressure on the switch to ensure that the contact is made. If the switch must be maintained in

the closed position for long periods of time or used frequently, the task of operating the switch can be quite fatiguing to the hand (as indicated by operator comments).

COMMENTS/POSSIBLE IMPROVEMENTS: Redesign accordingly. The operator should be able to tell by feel that the circuit has been closed. The force required to operate the switch should be great enough to prevent accidental activation but not so great as to be fatiguing.

Section 3: Display

3.01 **OBSERVATION:** The edges of the LED display can be read from a maximum angle of approximately 12 degrees above and below, 20 degrees to the left, and 25 degrees to the right. The display characters are larger than they need be, causing their edges to be close to the edges of the display where they are easily blocked from view.

IMPACT: It is impossible to read the edges of the display from operating positions outside the described perimeter. An unobstructed view of the display requires viewing from an inconveniently small central location in front of the control panel. Viewing from outside this area can cause misreadings. For example, if the top edge of the display is cut off by viewing from above, 1's and 7's are both seen as 1's. If the bottom edge is cut off, I's and L's look the same (as each other and as the 1's and 7's just mentioned). Cutting off an edge can cause confusions between 3's, 8's, and 9's, between 9's and A's, between t's and b's, etc. This problem is compounded by the fact that normal viewing angles are often outside the optimal viewing area.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, the display would allow viewing from at least 45 degrees in all directions. Decreasing the size of the display characters would partially solve the problem. Other solutions would involve physical changes in the display window, the features of the surrounding panel material, or both. MIL-STD-1472C offers the following guidelines: "[Displays] shall be mounted as close as possible to the panel surface so as to minimize parallax and shadows and maximize the viewing angle (par. 5.2.6.2.2). . . . The surface of the [display] and surrounding areas shall have a dull finish to minimize glare (par. 5.2.6.2.6). . . . For critical functions, indicators shall be loacted within . . . 15 degrees of the operator's normal line of sight (par. 5.2.2.1.7)." Regarding the last statement it should be noted that the normal line of sight for the ITT SINCGARS radio operator is often as much as 45 degrees off the perpendicular; thus the need to maximize the viewing angle.

3.02 **OBSERVATION:** The quality of display prompts and feedback suffers because of the limitations inherent in the 7-element, 5-character display.

IMPACT: The following annotated list depicts the manner in which the LED display can present alphabetical and numerical characters.

	Display Presentation			
Character (generic)	Upper-case	Lower-case	Special character	Comment
A				
B				Same as "6."
C				
D				
E				
F				
G				Cannot show generic.
H				
I				Cannot show centrally; same as "1."
J				Not used.
K				Not used; cannot show generic.
L				Lowercase is superscript.
M				Not used; cannot show generic.
N				Cannot show generic.
O				Both used. Uppercase is same as zero.
P				Not used.
Q				Not used; cannot show generic.
R				Cannot show generic.
S				Same as "5."
T				Cannot show generic.
U				Not used.

Continued

Character (generic)	Display Presentation: Upper-case	Lower-case	Special character	Comment
V				Not used; cannot show generic.
W				Not used; cannot show generic.
X				Not used; cannot show generic.
Y				Not used; cannot show generic.
Z				Not used; cannot show generic.
1			1	Cannot show centrally; same as "I."
2	2			
3	3			
4	4			
5	5			Same as "S."
6	6			Same as "B."
7	7			
8	8			
9	9			
0	0			Same as "O."

The limitations evident in the list presented above lead to occasional confusion in reading the display, especially for the trainee, and, more important, to a limitation on the number of terms that can be successfully used as prompts or for feedback. For example, the term "empty" cannot be used to indicate an empty channel. Instead, the radio displays the prompt "FILL," which instructs the operator to "fill" the channel even when such an action would be inappropriate. (The radio could, incidentally, display the term "FrEE" instead of "FILL," which would correctly provide the intended information.) The limitations also

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discourage the use of some terms that could be displayed because they would tend to look strange. Being incapable of presenting all alphabetical characters either in upper or lower case, the display presents them mixed together in a meaningless and confusing manner. The most anomalous character for trainees is the special character " /_ " used to represent "t." One consequence of this character is a confusion between the terms "tod" (time-of-day) and "bad," which tend to look alike until the operator gets used to them.

COMMENTS/POSSIBLE IMPROVEMENTS: A more versatile display could significantly enhance the ease of learning to operate the ITT SINCGARS, primarily becuase of the expanded feedback and prompt capabilities. In addition, it could significantly cut down on training time required, reduce the need for remedial training, lessen the frequency of operator errors, and enhance the operator's troubleshooting skills. With the current display, the use of confusing special characters should be avoided to the extent possible, and the appropriate use of prompts such as "FrEE' instead of "FILL" (where appropriate) should be ensured.

Section 4: Labels

4.01 **OBSERVATION:** The labels on the surface of the control panel are embossed.

IMPACT: The paint on the raised labels is exposed to excessive wear. Worn-off paint would make the labels even more difficult to read in low-light situations (see Observation 2.01).

COMMENTS/POSSIBLE IMPROVEMENTS: Slightly depressed labels should protect label paint and resist collection of dirt. (Earlier versions of the ITT SINCGARS had depressed labels.)

4.02 **OBSERVATION:** The label "LD-V" on the FCTN switch denotes "load variable," yet it is used for loading only the TRANSEC variable. The other "variables" (lockouts, hopsets, and time-of-day) are not loaded in the LD-V position. Hence, the label is too general in its connotation.

IMPACT: The trainee must learn to ignore the general implication of the label and remember to use the LD-V position only for loading the TRANSEC variable.

COMMENTS/POSSIBLE IMPROVEMENTS: "LD-V" should be "LD-T," so that the denotation would be "load TRANSEC." This would be consistent with the corresponding label on the ECCM fill device and avoid the implication of lockout and hopset "variables."

4.03 **OBSERVATION:** The label "ENT" on the store key is redundant and serves no purpose.

IMPACT: This label, which appears in all upper case letters below the label "Sto," (which is a capitalized lower-case abbreviation), is confusing and can be mistaken as a secondary function of the key.

COMMENTS/POSSIBLE IMPROVEMENTS: Although "enter" is perhaps a better choice of terms than "store" (see Observation 4.10), only the abbreviation "Sto" appears in the display. If "Sto" is retained as the display terminology, the solution would be to remove the "ENT" label from the key. However, a better solution would be to use "Ent" or "EntEr" in the display and remove "Sto" from the key. (Neither of these solutions avoids the use of special display characters, however--see Observation 3.02.)

4.04 **OBSERVATION:** The Sto/ENT key is not labelled for the scanning (SCAN) function.

IMPACT: Operators are forced to remember the scan procedure with no initial machine prompt; consequently, the procedure may be forgotten.

COMMENTS/POSSIBLE IMPROVEMENTS: All key functions should be denoted by corresponding key labels. (Because the terms "Sto" and "ENT" are redundant, one of them could be removed to make room for "SCAN." See Observations 4.03 and 4.10.)

4.05 **OBSERVATION:** The label "H·Ld" on the so-called "hold/load" key is unconventional and something of a misnomer.

IMPACT: The label is confusing. The rationale behind its use is that the key "loads" the "holding" memory with a lockout or hopset--which, parenthetically, would imply "Ld·H" rather than "H·Ld." The trainee may be confused by the implication that the key has two distinctly different functions and that the two functions are somehow related in a special way indicated by the dot separating "H" and "Ld."

COMMENTS/POSSIBLE IMPROVEMENTS: Because the most common function of the key is to initiate a process that retrieves information from "permanent" memory, a simple term like "recall" (RCL) or "recall memory" (RM) or "memory recall" (MR), would simplify matters greatly. (Of course, the current display would have difficulty presenting the abbreviations appropriately. See Observation 3.02.) A partial solution would be to change the label to "LOAD," recognizing that the "recall" aspect would not be specified. The best solution might be to remove the function to a non-numbered key so that there would be room for a label such as

RCL
LOAD

.

4.06 **OBSERVATION:** The abbreviation "L.E." on the keyboard (on the "3" key) denotes "late entry," which appears to be a misnomer because the purpose of the procedure to which it refers (according to the Operator's Manual, p. 2-59) is to regain lost or suspended communication with a net, not to

enter a net late (see Observation 4.18). The procedures for a bona fide late net entry (cue and ERF) are completely different (Operator's Manual, pp. 2-59, 60).

IMPACT: The purpose of the procedure is not well understood by operators. The procedure is difficult to teach to trainees, who must learn that "late entry" procedures are not used for bona fide late net entry.

COMMENTS/POSSIBLE IMPROVEMENTS: Terminology in this area needs clarification. Perhaps the term "late entry" should be used only in connection with true late net entry (cue and ERF) procedures. Establish appropriate terminology for use in connection with regaining lost communications. The concept "time synchronization" might be useful in this regard, because resynchronization is the technical requirement of the procedure and the terminology would be meaningful to operators. The abbreviation "SYNC" could replace " L.E." on the keypad--but note Observation 4.18.

4.07 **OBSERVATION:** The labeling for the audio/fill connector, the audio/data connector, and the data switch (including the linear guide marks) is perplexing.

IMPACT: The trainee must learn the use of the two connectors and the switch before the meaning of the labeling becomes clear. Hence, the labeling is a detriment to learning rather than an aid.

COMMENTS/POSSIBLE IMPROVEMENTS: Label the top connector "AUD/FILL"; put the label above and to the left of the connector. Label the bottom connector "AUD/DATA"; put the label under the connector. Label the switch "DATA RATE"; put the label under the switch. Eliminate the linear guide marks.

4.08 **OBSERVATION:** The label "RF" (standing for "radio frequency") on the transmit power switch does not indicate the function of the switch. The switch controls power, not frequencies.

IMPACT: In training the current label may be detrimental because the trainee must learn that the function of the switch is not that implied by the label.

COMMENTS/POSSIBLE IMPROVEMENTS: Change "RF" to "XMT POWER" (transmit power), "RF POWER" (radio frequency power), or some other appropriate label.

4.09 **OBSERVATION:** The term "manual" (as in "MAN CHAN"), used to designate the digital channel position on the CHAN switch, is a misnomer in that it implies that this channel, unlike the other seven, is somehow not automatic (i.e., operated manually). This distinction appears to be entirely superfluous, having no bearing whatsoever on the operating features of any of the channels.

IMPACT: Even seasoned operators are confused about the purpose, proper usage, and nature of the "MAN" channel.

COMMENTS/POSSIBLE IMPROVEMENTS: Replace the term with an appropriate and informative designator that connotes the digital or administrative character of the channel. Provide additional operator training on this topic.

4.10 **OBSERVATION:** The label "Sto" (store) on the keypad and the label "STW" (stow) on the FCTN switch are apt to be confused when they are verbalized because "Sto" is often erroneously verbalized as "stow" rather than "store." This error is made by instructors as well as operators.

IMPACT: Trainees may be confused when they hear "sto" if they have not yet learned the contextual cues that would imply "store" as opposed to "stow." Furthermore, even the terms "store" and "stow" have similar generic meanings, and the trainee must learn that, with respect to the ITT SINCGARS, they have entirely different meanings.

COMMENTS/POSSIBLE IMPROVEMENTS: Replace the term "store" with the term "enter." Use "ENT" (only) on the keypad and "Ent" in the display--but see Observation 4.03.

4.11 **OBSERVATION:** The virgule in the label "FH/M" is not consistent with the meaning of the label or with other analogous labels on the control panel ("LD-V," "Z-A").

IMPACT: The virgule improperly denotes a relation between FH and M that is different from the relation between LD and V and between Z and A. The relation is the same.

COMMENTS/POSSIBLE IMPROVEMENTS: Change "FH/M" to "FH-M."

4.12 **OBSERVATION:** In radio terminology the generic meaning of the term "send" is "transmit." Either of these terms would ordinarily be used to refer to any radio transmission whatsoever, regardless of type. Yet, the ITT SINCGARS reserves the term "send" for transmitting ERF's only, whereas "transmit" is used for all other transmissions. Thus the label "SEnd" on the keypad is not employed in a standard manner.

IMPACT: The trainee must learn that "send" does not mean "transmit" in its general sense, but "transmit ERF."

COMMENTS/POSSIBLE IMPROVEMENTS: Change the label "SEnd" to "ERF" (electronic remote fill), which has the precise meaning intended and is thoroughly familiar to all operators with minimal training. (See comment for Observation 4.17.)

4.13 **OBSERVATION:** The dim control markings do not indicate brightness level. The crescent mark (scale) on the knob has no reference.

IMPACT: The control cannot be preset to a desired brightness, an especially desirable feature for the manpack version where it may be important under light discipline to avoid inadvertently exposing a bright display.

COMMENTS/POSSIBLE IMPROVEMENTS: If the crescent scale on the control knob is to be retained, it should be moved from the knob to the face of the panel and reversed in orientation; a reference mark and shape coding should be incorporated into the knob design. A better solution might be a shape-coded knob with several reference marks on the panel face with a label indicating two or three brightness levels, e.g., "OFF," "MIN," "DIM," "MAX," "BRIGHT," or other appropriate terms or numbers.

4.14 **OBSERVATION:** The volume control markings do not indicate volume level. The crescent mark (scale) on the knob has no reference.

IMPACT: Analogous to that of Observation 4.13.

COMMENTS/POSSIBLE IMPROVEMENTS: Analogous to that of Observation 4.13.

4.15 **OBSERVATION:** The FREQ key is used to identify lockouts, yet there is no indication of this function on the key.

IMPACT: Operators are prone to forget how to identify lockouts stored in the radio. Trainees forget which key controls the function.

COMMENTS/POSSIBLE IMPROVEMENTS: At first glance, labeling the FREQ key for the lockout identification function would seem to be the logical solution; however, the FREQ key is already overworked and is the logical place for the frequency offset function, which is currently associated with the "SEnd" key (see Observations 2.06 and 4.18). The lockout identification function could be moved to the BATT/CALL key where it would replace the battery function (which apparently serves no useful purpose).

4.16 **OBSERVATION:** The so-called "memory test" function associated with the Z-A position of the FCTN switch is not indicated by the "Z-A" label. The meaning of the display feedback "Good" at the end of the test is unclear. The purpose and need for the test is not adequately explained by trainers or by the Operator's Manual.

IMPACT: Trained operators are unaware of this "memory test" and do not understand the meaning of the feedback term "Good." They tend to ignore the test during start up procedures, proceeding directly through the Z-A position to the "TST" function, where, as a consequence, false "FAIL" messages are sometimes received.

COMMENTS/POSSIBLE IMPROVEMENTS: Additional clarification of the import and purpose of the Z-A "memory test" needs to be offered during the operator training and incorporated into the Operator's Manual. The display term "Good" might be replaced with a term like "Clr'd" (cleared)

or "donE." If the function of the test is more than a mere indication of the completion of the zeroizing process, that function should be so indicated at the Z-A position of the FCTN switch.

4.17 **OBSERVATION:** The change-sign function (+/-) used for entering negative frequency offsets is not indicated on the key that controls it (the SEnd/OFST key).

IMPACT: The method of entering a negative offset is confusing to the trainee and may tend to be forgotten by operators who do not use the radio frequently.

COMMENTS/POSSIBLE IMPROVEMENTS: Indicate the function +/- on a key, preferably not the SEnd/OFST key. However, if the SEnd/OFST key must be used, a possible method of accomplishing this would be $\dfrac{\underline{\text{SEND}}}{\text{FO}/\pm}$ or, taking account also of the potential solution offered in Observation 4.12, a better label might be $\dfrac{\underline{\text{ERF\_}}}{\text{FO}/\pm}$, where "FO" stands for "frequency offset."

4.18 **OBSERVATION:** The so-called "late-entry" function is not indicated on the FREQ key, which is used to initiate it. The label "FREQ" is not sufficient because it does not denote "late entry" and is already used to indicate other operations (identifying, loading, and clearing in connection with SC frequencies, hopsets, and lockouts). The label "L.E." on the "3" key is inappropriate because that key is not used to initiate the procedure.

IMPACT: Operators may forget how to enter the so-called "late entry" mode. Because the "3" has the label "L.E." on it, the natural tendency is to press L.E. first, rather than FREQ. Because of these complications, operators may often ignore this convenient (and safe) way to reestablish communications.

COMMENTS/POSSIBLE IMPROVEMENTS: If the FREQ key is to be used to initiate the "late entry" procedure, then it should be so labeled (although the term "late entry" is not recommended--see Observation 4.06). However, the FREQ key is already overworked and needs another additional label for lockout identification (see Observation 4.15). Therefore, a better solution would be to establish a different procedure for either "late entry" or lockout identification that does not involve using the FREQ key.

Section 5: Connectors and Cables

5.01 **OBSERVATION:** Operators complained about the number of cable connections required for vehicular configurations.

IMPACT: Complex and time-consuming installation procedure, possibly prone to error.

COMMENTS/POSSIBLE IMPROVEMENTS: Minimize the connections that operators must manually accomplish. Appropriately designed vehicle mounts might allow some connections to be made automatically via the installation itself.

5.02 **OBSERVATION:** Operators noted that some cable plugs were difficult to plug into their connectors. Specifically mentioned was the W2 cable connecting the antenna connector on the radio with the J2 connector on the power amplifier.

IMPACT: Cable connecting sometimes required excessive time. Operators (and instructors) used saliva to lubricate connectors--which might present a problem in extremely cold weather.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide connectors and plugs that are easily assembled and disassembled.

5.03 **OBSERVATION:** The J5 connector for the KY-57 (VINSON) is located on the side of the radio.

IMPACT: A mounted vehicular radio must be removed from the mount in order to connect the KY-57, a time-consuming procedure.

COMMENTS/POSSIBLE IMPROVEMENTS: The connector might be moved to the rear panel of the radio where it would feed into the mounting adapter. (The feasibility of this suggestion is unknown.)

5.04 **OBSERVATION:** One operator noted that the radio can be incorrectly cabled; i.e. certain cables can be connected to the wrong receptacles.

IMPACT: Inability to operate or degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, it should be impossible to connect a plug to the wrong receptacle. Connectors should be keyed to accept only the correct cable.

5.05 **OBSERVATION:** On the radio examined, the antenna receptacle on the front of the radio was not provided with a protective cap.

IMPACT: The connector is exposed to debris and possible damage.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide cap.

5.06 **OBSERVATION:** On the radio examined, the protective cap on the J5 connector on the side of the radio would not lock into position; it would fall away easily.

IMPACT: The connector may be exposed to debris and possible damage.
COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the protective cap is designed to remain securely on the connector.

5.07 **OBSERVATION:** The alignment keys on the protective caps for the audio (AUD) and retransmission (RXMT) receptacles are difficult to engage. It is cumbersome to install the caps--even though the caps are coded with external depressions indicating the location of alignment keys in the caps. (There is no corresponding coding on the receptacles.) The problem is compounded by the crowded nature of the panel.

IMPACT: Installation of the caps is unnecessarily time consuming. The caps may not be appropriately utilized.

COMMENTS/POSSIBLE IMPROVEMENTS: All connectors should be designed for ease of use.

Section 6: Operational Procedures

6.01 **OBSERVATION:** The "load and store" procedure for storing a TRANSEC variable in the primary memory consists of pressing a single key--the H·Ld/0 key--after the correct switches have been set and the fill device connected. The Sto/ENT key is not to be used even though the display "beeps" and momentarily shows "Sto t" after the H·Ld/0 key has been pressed. The operator's procedure for storing an additional TRANSEC variable in the holding memory is the same--the single key H·Ld/0 is pressed. (See Observation 6.02.)

IMPACT: A natural mistake here is to press the Sto/ENT key, either instead of or in addition to the H·Ld/0 key. In attempting to store an additional TRANSEC variable in the holding memory, use of the Sto/ENT key will erase the TRANSEC variable stored in permanent memory.

COMMENTS/POSSIBLE IMPROVEMENTS: The loss of stored information appears to have been a significant problem with the radio--in past operational evaluations as well as the current one. Perhaps the sort of problem cited here has been contributory. The radio should be provided with overwrite protection so that unintentional deletion of stored information is made highly improbable.

6.02 **OBSERVATION:** The "load and store" procedure for loading a hopset (local fill), in contrast to the procedure described in Observation 6.01, involves pressing two keys--H·Ld/0 followed by Sto/ENT (and the channel number). The two procedures are inconsistent.

IMPACT: The tendency to use the Sto/ENT key erroneously when loading a second TRANSEC variable (see Observations 6.01) is perhaps enhanced by its required use when loading hopsets.

COMMENTS/POSSIBLE IMPROVEMENTS: Loading/holding/storing procedures should be consistent from task to task so that the cognitive requirements for the operator are minimized. The terms "load," "hold," and "store" should be clearly and distinctly defined and operationalized.

6.03 **OBSERVATION:** The frequency offset prompt ("--") implies that a two-digit response is required.

IMPACT: An attempt to enter "05" for a 5 kHz offset will not only fail to establish a 5 kHZ offset but will also erase any previously entered offset by entering "00" instead. This procedure is inconsistent with those for entering time-of-day, where, for example, "five minutes" must be entered as "05." To establish a 5 kHz offset, the operator must ignore the two digit request and enter the single digit "5." If the operator carelessly enters "05" instead, SC communications will be lost until the error is detected and corrected.

COMMENTS/POSSIBLE IMPROVEMENTS: To establish a 5 kHz offset, the operator should be able to enter either "0" or "5" as the first digit. If "0," the radio should wait for the second digit and allow either another "0" (to erase any previous offset) or a "5," (which would overwrite any previous setting). If "5" is entered as the first digit, then no second digit should be allowed. (If "1" is entered as the first digit, the second digit ["0"] should be automatically entered by the radio to establish a 10 kHz offset.)

6.04 **OBSERVATION:** The Operator's Manual states in a footnote (p. 2-34) that single-channel frequencies can be loaded into the so-called "manual" channel with the function switch in positions other than LD: SQ ON, SQ OFF, and RXMT. The Operator's Manual fails to note that the channel can also be loaded with the FCTN switch set to LD-V.

IMPACT: The astute operator may be curious about the apparent omission and wonder whether there is a special but unspecified reason for avoiding LD-V position while loading the "manual" channel.

COMMENTS/POSSIBLE IMPROVEMENTS: The LD position should have consistent application: the radio should accept single-channel frequencies only when the FCTN switch is set to LD.

6.05 **OBSERVATION:** The clear function is not effectively utilized; the manual clearing of the display before entering new data is an unnecessary step.

IMPACT: When the operator wishes to enter or change single-channel frequencies, frequency offsets, or time-of-day, the FREQ, OFST, or TIME key is pressed. This action displays the currently stored frequency, offset, or time data. Then the CLR key must be pressed to replace the

displayed information with a blank-line prompt. The operator then keys in the required new datum (fills in the blanks) and stores it. In the sequence just described, the CLR-key step appears to serve no useful purpose. It neither informs the operator of anything not already known nor adds significant protection against accidental loss of information. Consequently, it appears to be an unnecessary complication and a waste of time.

COMMENTS/POSSIBLE IMPROVEMENTS: For all practical purposes, the FREQ, OFST, and TIME procedures would be more efficient if the CLR step were simply omitted, as in the following example (note that the zero is entered automatically):

```
    Key:   [FREQ]    [4]      [6]      [2]      [5]      [STO]

                                                         \\!//
Display:  [30000]  [4....]  [46...]  [462..]  [46250]  [46250]
                                                         //!\\
                                                        [blink]
```

A better sequence would include an overwrite protection step:

```
    Key:     "        "        "        "        "      [STO]    [STO]

                                                        \\!//
Display:     "        "        "        "        "     [46250]  [donE ]
                                                        //!\\
                                                       [rapid
                                                        flash]
```

The flash should occur at a rate of about one per second, remaining on each time long enough for the display to be read. A minimum of two flashes should be required before the next step is enabled.

The proper function for the CLR key should be to clear the memory in a dual-step procedure like the following:

```
    Key:   [FREQ]    [CLR]    [CLR]

                     \\!//
Display:  [46250]  [46250]  [donE ]
                     //!\\
                    [rapid
                     flash]
```

6.06 **OBSERVATION:** One operator noted that it should be easier to distinguish between being out of synchronization and a radio malfunction.

IMPACT: The comment implies that operators may waste more time than necessary applying illogical solutions or inefficient procedures to problems encountered.

COMMENTS/POSSIBLE IMPROVEMENTS: Operators may benefit from additional troubleshooting training so that they are prepared to apply a logical sequence of remedial procedures upon encountering an operational problem.

6.07 **OBSERVATION:** One operator complained that the cue signal caused confusion within the net ("may get people lost switching back and forth").

IMPACT: Possible loss of communication among net members.

COMMENTS/POSSIBLE IMPROVEMENTS: The comment may imply insufficient training in cue procedures. It may also imply a need for a more versatile cue capability such as the option to cue a single receiver (NCS) rather than the entire net.

6.08 **OBSERVATION:** Operator comments indicated concern about the procedures for reestablishing contact with the net after communication has been lost--especially if an ERF is required. (One operator stated: "Personally, I could not go through all these tasks during a road march with tanks or during operations.")

IMPACT: Degraded or lost communication capability.

COMMENTS/POSSIBLE IMPROVEMENTS: There were indications in the operator comments that the training in ERF procedures was inadequate. On the other hand, the procedures are complicated, especially when the VINSON (KY-57) is in use--the NCS is required to perform many steps. Ideally, the procedure would be simpler.

6.09 **OBSERVATION:** The Operator's Manual states that the radio should not be turned off if the ambient temperature drops below +20 degrees Fahrenheit. Otherwise the presets may be lost.

IMPACT: If the operator allows the radio to become cold, communication may be precluded.

COMMENTS/POSSIBLE IMPROVEMENTS: The Operator's Manual discusses this problem in a section near the end of the manual called "Operation Under Unusual Conditions." The necessity of operating in temperatures below +20 degrees Fahrenheit should not be considered unusual. If the probability of losing presets is significant at temperatures below +20, certainly the importance of keeping the radio warm should be greatly stressed during operator training.

6.10 **OBSERVATION:** The validity of the battery-low indication is dependent upon the accuracy of manually stored information (indicating when the

battery was installed in the radio). The requirement for operators to log battery amp-hours is ill-advised. It is unlikely that the requirement will be met.

IMPACT: The battery-low indication is not a reliable indicator. The operator will have insufficient or inadequate warning of the imminent failure of the battery; communications may be lost, interrupted, or otherwise degraded.

COMMENTS/POSSIBLE IMPROVEMENTS: Scrap the requirement for operators to keep track of battery life manually. Ensure that fresh batteries are always available. If feasible, devise an automatic warning of imminent battery failure--if the amount of time remaining would allow the operator to exchange batteries without a a totally unexpected interruption of communication. If it is a high priority for the operator to be able to ascertain remaining battery life, additional consideration should be given to utilizing a different kind of battery.

6.11 **OBSERVATION:** The battery housing box has four spring clips for securing the box to the radio. The clips are easy to close, and they appear to provide a very secure attachment; however, they are difficult to impossible (depending on the operator) to open without some sort of leverage tool (such as a screwdriver). (See Observation 6.12.)

IMPACT: The time required to change the battery will often be extended in proportion to the time required for the operator to locate and apply an appropriate tool.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide clips that open easily without a tool but remain secure when in place.

6.12 **OBSERVATION:** The battery box clips spring open with great force.

IMPACT: The operator who is able to spring open the clips without a tool may sustain a very painful blow to the fingers.

COMMENTS/POSSIBLE IMPROVEMENTS: Same as for Observation 6.11.

Section 7: Communication

7.01 **OBSERVATION:** The operators made several comments complaining about static that they attributed to inclement weather, long communication distances, or the VINSON (KY-57) equipment. (One operator commented: "The security device creates intense static." Another stated: "Bad weather and temperature change has created massive static in transmssions.")

IMPACT: The extent to which the VINSON (KY-57) was responsible for increased noise level was undetermined. That aside, excessive volume is often required to overcome weak or distorted transmissions and static.

The extent (if any) to which this higher volume could be harmful to the operator's hearing is undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: It should be determined by objective measurements and assessments whether the volumes and their durations constitute a significant hazard to the operator.

7.02 **OBSERVATION:** One operator remarked that the auditory cue signal should be louder and consist of a different sound.

IMPACT: Possible missed signals. Possible confusion with other signals.

COMMENTS/POSSIBLE IMPROVEMENTS: Determine whether the signal, as is, might at times be confused with other auditory signals emitted by the radio. Modify accordingly.

Section 8: Miscellaneous

8.01 **OBSERVATION:** The battery is not integral to or secured within the battery box.

IMPACT: The battery, including its electrical connector, is susceptible to damage from dropping when the housing is removed for battery exchange. The battery can fall out or be removed at an angle, which exerts a twisting or bending force on the receptacle.

COMMENTS/POSSIBLE IMPROVEMENTS: The battery should be protected from accidental damage caused by dropping or inappropriate removal by ensuring that it cannot be removed from the radio at an angle. This could be accomplished by providing alignment keys on the housing and by securing the battery within the housing so that the housing and the battery must be removed as a unit--and subsequently separated for battery exchange.

8.02 **OBSERVATION:** On the radio examined, the gasket between the battery box and the radio was not well attached--the glue was not holding.

IMPACT: If the seal is lost during battery exchange, the battery housing would than be susceptible to leakage.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide an adequately durable seal.

8.03 **OBSERVATION:** One operator noted that the radio in its backpack configuration is difficult to balance for operating on the ground.

IMPACT: An inconvenience.

COMMENTS/POSSIBLE IMPROVEMENTS: It might be feasible to modify the backpack frame so that it could be used as a prop for the radio.

MARCONI: DETAILED OBSERVATIONS

The following observations derive from two sources: (a) written comments of the 12 soldiers trained to operate the Marconi radio; (b) the findings of two human factors specialists who independently assessed the operator-radio interface characteristics of the radio. The "comments" and "possible improvements" are offered as suggestions only. They are not necessarily exhaustive, sufficient, consistent with one another, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine.

Section 1: Operator's Manual

1.01 **OBSERVATION:** On a scale from -100 (poor) to +100 (good), the Marconi manual (User Handbook, BL 5525, Issue 3, April 1986) was given the following scores by the reviewers (two human factors specialists): Content (+31); Readability (+50); Illustration (+50); Durability (+50). An overall mean of +43 was obtained by weighting the four content areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean indicated that the manual was adequate in most respects. Areas receiving negative evaluations were the following: table of contents, subject index, safety hazards, spacing, reading level, number of illustrations (too many), and durability.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly. It should be noted that the flip-card pocket manual ("Scimitar-V Radio Operators Cards") that accompanied the User Handbook was rated quite highly, receiving negative evaluations primarily in the areas of operator maintenance instructions and spacing (layout). It was simple and durable. (See Observations 1.13-1.15.)

1.02 **OBSERVATION:** The manual is in ringbinder format.

IMPACT: It is easy to mislay pages that are not numbered, such as the photographs of the backpack and vehicular configurations. It is also easy to lose pages from a ringbinder.

COMMENTS/POSSIBLE IMPROVEMENTS: While the ringbinder format has certain advantages (e.g., it is easy to replace pages), care must be taken to designate the proper position of each page. Some consideration should be given to using a different binding.

1.03 **OBSERVATION:** The manual format (cover: 9 1/2 x 12 1/4 inches) is too large.

IMPACT: The manual is bulky and cumbersome to use except in the classroom or other situations where a desk-like surface is available. The manual is obviously not intended for field use. Much space is wasted; for example: (a) Part 1 begins with three introductory pages that are

redundant; (b) page 2.1 could easily be incorporated into pp. 2.2 and 2.3; (c) there is a considerable amount of empty space that could be eliminated (e.g., pp. 3.16-3.20 and many more) without undue crowding.

COMMENTS/POSSIBLE IMPROVEMENTS: The manual's size and length could easily be improved (made smaller and shorter) by the judicious use of space (which would include the elimination of some of the redundant illustrations).

1.04 **OBSERVATION:** The margin tabs, used to mark Sections 1, 2, 3, and 4 are labeled with the numbers "1" through "4."

IMPACT: While the tabs make it easy to refer to a particular section, they provide no information about section contents.

COMMENTS/POSSIBLE IMPROVEMENTS: The tabs should give the titles of the sections to which they refer: "INTRODUCTION," "DESCRIPTION," "OPERATION," "MAINTENANCE."

1.05 **OBSERVATION:** The table of contents has no page numbers.

IMPACT: It is unnecessarily difficult and time consuming to locate the desired information.

COMMENTS/POSSIBLE IMPROVEMENTS: The table of contents should refer the reader to the appropriate page.

1.06 **OBSERVATION:** The page numbering system is complicated by (a) the presence of introductory pages at the beginning of each chapter ("Part"). Parts 1, 2, and 3 use a Roman numeral series for the introductory pages (e.g., "ii"), while Part 4 uses a combination Arabic/Roman series (e.g. "2.(ii)".)

IMPACT: The numbering system is confusing and adds to the difficulty of quickly locating the desired material.

COMMENTS/POSSIBLE IMPROVEMENTS: Introductory pages should probably be eliminated (see Observation 1.03). If retained, each chapter should start with page "1" (e.g. 1.1, 2.1, etc.)

1.07 **OBSERVATION:** The manual has no index.

IMPACT: It is difficult for the operator to locate specific information quickly.

COMMENTS/POSSIBLE IMPROVEMENTS: Although the manual has a table of contents that is rather detailed, the manual would be improved significantly with the addition of a complete index so that the operator could locate information by keywords rather than by topic.

1.08 **OBSERVATION:** The coded illustrations of the front panel (e.g., Figure 2-1, p. 2.1) are not accompanied by a key. Instead, references to the illustrations are spread throughout the text.

IMPACT: The reader is forced to flip through the pages to identify the features of the panel--an annoying and inefficient use of time.

COMMENTS/POSSIBLE IMPROVEMENTS: At an appropriate location (near the beginning of the manual) there should be a master illustration of the front panel accompanied by a complete list of identifying information. Switches and controls should be identified by name on the illustration.

1.09 **OBSERVATION:** The two views of the antenna tuning unit on p. 2.18 appear upside down.

IMPACT: Operator/trainee confusion.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

1.10 **OBSERVATION:** The illustration of the antenna tuning unit on p. 2.28 appear upside down.

IMPACT: Operator/trainee confusion.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

1.11 **OBSERVATION:** In the glossy photograph entitled "SCIMITAR V - MANPACK ROLE," the radio is pictured from the bottom at an angle that does not show the front panel.

IMPACT: The picture is uninformative. Indeed, it may be difficult for the trainee to discern whether the bottom or top of the radio is pictured. Interpretation of the picture depends upon prior knowledge of what the radio looks like or on a comparison with other illustrations.

COMMENTS/POSSIBLE IMPROVEMENTS: Depict the radio from the front left.

1.12 **OBSERVATION:** The manual uses the term "parameters" in two different ways, as specifications ("physical," "electrical," "receiver," and "transmitter" parameters) and as variables ("key variables," "hopping frequencies," and "clock time").

IMPACT: The trainee may be confused.

COMMENTS/POSSIBLE IMPROVEMENTS: The word "specifications" should be substituted for the former usage, and "parameters" should be retained for the latter.

1.13 **OBSERVATION:** The format of the flip cards (pocket manual) that accompanies the User Handbook is vertical (3 1/2 x 5 1/2 inches) and bound at the top. When opened to two pages, the top page is upside down.

IMPACT: It is difficult to locate the desired card. The illustrations are narrow.

COMMENTS/POSSIBLE IMPROVEMENTS: This pocket manual could be improved by using a horizontal rather than a vertical format, i.e., book style. One advantage would be that the front panel illustrations could be larger (they would use up some of the wasted space at the bottom of the pages). Also, pages should follow consecutively--i.e., Card 1 should be on the back of the cover, Card 3 should be on the back of Card 2, etc. When opened to two pages, both pages should be able to be read without turning the manual upside down.

1.14 **OBSERVATION:** The flip-card pocket manual provided for the assessment contained four pages at the end that were not laminated.

IMPACT: These pages are not durable.

COMMENTS/POSSIBLE IMPROVEMENTS: Apparently these pages were added to the pocket manual as an afterthought. All permanent cards should be laminated.

1.15 **OBSERVATION:** The plastic binding on the flip-card pocket manual does not allow the pages to be folded completely over.

IMPACT: If the operator forces the pages too far, they tend to come out of the binding. Therefore, the manual must be opened to two pages at all times while in use, which is awkward and requires additional shelf space.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a binding that allows each card to be folded completely over onto the back of the previous card.

Section 2: Operating Controls

2.01 **OBSERVATION:** The front panel controls are not illuminated for use in low-light or no-light situations. Operators view this as a significant problem.

IMPACT: The lack of panel lighting makes it difficult or impossible for operators to manipulate the controls effectively in the dark without some sort of external light source, such as a flashlight, which may breach security.

COMMENTS/POSSIBLE IMPROVEMENTS: Consider providing back-lighting or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

2.02 **OBSERVATION:** With the exception of the MODE switch, all control knobs were mounted so that their pointer sides were slightly to the right of the correct position.

IMPACT: The offset increases the probability of misreading the position of a switch, especially when viewed from side angles.

COMMENTS/POSSIBLE IMPROVEMENTS: Mount the knobs accurately. The design of the knob and switch spindle should preclude inaccurate assembly.

2.03 **OBSERVATION:** The control knobs on the preset, mode, display setting, and function switches are symmetrical.

IMPACT: Although the knobs are coded to indicate the pointing direction, the shape alone does not provide unambiguous indication of switch settings, especially in low-light or dark or from side angles of view.

COMMENTS/POSSIBLE IMPROVEMENTS: Use knobs with shapes that point, irrespective of any reference markings they may possess. The shape should minimize parallax distortion (normally achieved by sloping pointer toward reference marks on panel face). Conform to the design specifications presented in MIL-STD-1472C.

2.04 **OBSERVATION:** Two operator comments indicated that the proximity of the volume control and function switch sometimes caused the setting of the latter to be changed inadvertently.

IMPACT: Possible lost of voice communication.

COMMENTS/POSSIBLE IMPROVEMENTS: The problem could be minimized by placing the volume control and function switch farther apart and by increasing the resistance of the detents on the function switch. (Ref. MIL-STD-1472C, par. 5.4.2.2.1.)

2.05 **OBSERVATION:** One operator suggested that the display setting switch should have a "knob stop" at the "P SET" position.

IMPACT: The operator may accidently overshoot the "P SET" position.

COMMENTS/POSSIBLE IMPROVEMENTS: Consider the advisability of increasing the resistance of the detent at the "P SET" position.

Section 3: Display

3.01 **OBSERVATION:** The edges of the display can be read from a maximum of approximately 40 degrees above, 31 degrees below, 29 degrees to the left, and 28 degrees to the right.

IMPACT: It is impossible to read the edges of the display from operating positions outside the described perimeter. It is possible to misinterpret characters, especially at the ends of the display.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase viewing angles, especially from the sides. Ideally, the display would allow viewing from about 45 degrees in all directions.

3.02 **OBSERVATION:** The display window scratches easily and may thus be prone to damage from physical abuse, especially in the backpack configuration.

IMPACT: Scratched display window. Degraded readability.

COMMENTS/POSSIBLE IMPROVEMENTS: Insure that the display window is strong and sufficiently resistant to scratching. Consider providing a protective shield.

3.03 **OBSERVATION:** The display is a six-character LED with each character limited to seven segments.

IMPACT: The display is limited in the extent to which it can portray meaningful information to the operator, especially because of the seven-segment limitation. For example, the display is incapable of portraying appropriate characters for the letters a, B, D, e, f, g, G, j, k, K, m, M, n, N, p, q, Q, r, R, s, t, T, v, V, w, W, x, X, y, Y, z, and Z. Under the circumstances, the display resorts to new, unfamiliar, and misinterpretable symbols, that require unwarranted learning and retention efforts on the part of the operator. Furthermore, 5 and S look the same; as do 6 and b, and 0 (zero) and O.

COMMENTS/POSSIBLE IMPROVEMENTS: Incorporate a more versatile display capable of appropriately presenting all information conveyed. Otherwise, maximize the meaningfulness of the current display by judicious selection of prompt and feedback symbology. One method of compensating for the limitations of this kind of LED is to provide alternating displays so that a message can be lengthened by presenting two or more message components successively. Also, avoid mixing numbers and letters that are represented by the same symbol in the same display message, such as 5's and S's; and avoid using similar or identical symbols to present different information.

Section 4: Labels

4.01 **OBSERVATION:** The label "EXT" on the preset switch is unnecessarily cryptic.

IMPACT: The label is not optimally informative. Instead of functioning as a learning aid, it constitutes a learning task, thus adding to the training and retention burden.

COMMENTS/POSSIBLE IMPROVEMENTS: The label could be improved by changing

it to: REMOTE SELECT , REM SEL , or the like. (See also Observation 6.04.)

4.02 OBSERVATION: The label "CL" on the mode switch is unnecessarily cryptic.

IMPACT: Same as for Observation 4.01.

COMMENTS/POSSIBLE IMPROVEMENTS: Change to "CLEAR," "PLAIN," or the like.

4.03 OBSERVATION: The label "SEC" on the mode switch is unnecessarily cryptic.

IMPACT: Same as for Observation 4.01.

COMMENTS/POSSIBLE IMPROVEMENTS: Change "SEC" to "SECURE," "CIPHER," or the like.

4.04 OBSERVATION: The labels "TXS" and "RXS" (mode switch) are unnecessarily cryptic.

IMPACT: Same as for Observation 4.01.

COMMENTS/POSSIBLE IMPROVEMENTS: Change "TXS" to "TX-SYNC," "XMTR-SYNC," or the like. Make an analogous change for "RXS"; i.e., "RX-SYNC," "RCVR-SYNC," or the like.

4.05 OBSERVATION: The virgule (/) in the label "A/J" (mode switch) should be a hyphen (-).

IMPACT: The virgule denotes a semantic parallelism between "A" and "J" that does not exist; also, it is inconsistent with the correctly used hyphen in the label "CALL-IC" (display setting switch).

COMMENTS/POSSIBLE IMPROVEMENTS: Change the virgule to a hyphen.

4.06 OBSERVATION: The label "A/J" on the mode switch is unnecessarily cryptic.

IMPACT: Same as for Observation 4.01.

COMMENTS/POSSIBLE IMPROVEMENTS: Change "A/J" to "ANTI-JAM," "FREQ HOP," "ECCM," or the like.

4.07 OBSERVATION: The label "P SET" on the display setting switch is unnecessarily cryptic.

IMPACT: Same as for Observation 4.01.

COMMENTS/POSSIBLE IMPROVEMENTS: Change "P SET" to "PRESET," or the like.

4.08 OBSERVATION: The label "CALL-IC" is misleading. This switch position simply enables the intercom function--it does not actually call the remote operator.

IMPACT: The operator must remember to press either "TEST" or "LOAD" button (see observation 4.09) in order to activate the call.

COMMENTS/POSSIBLE IMPROVEMENTS: Change the label "CALL-IC" to "INTERCOM."

4.09 OBSERVATION: The "TEST" and "LOAD" buttons are not labeled either for their intercom-call function or for their function of changing the display to a selective-call number.

IMPACT: The operator must remember how to activate these functions without a machine prompt--a learning/retention burden.

COMMENTS/POSSIBLE IMPROVEMENTS: As a general rule, every control should be labeled for each of its functions, and there should be no functions that are not represented by labels or other appropriate machine prompts.

4.10 OBSERVATION: Position 3 of the display setting switch has several different uses (e.g., selection of the power output level), none of which is indicated by a label. Furthermore, all but one of the uses is distinct from the uses of positions 4 through 7, whose functions are analogous to one another; yet there is no labeling distinction other than position itself.

IMPACT: The trainee or operator must remember the functions of the switch position without a machine prompt--a learning/retention burden.

COMMENTS/POSSIBLE IMPROVEMENTS: Same as for Observation 4.09.

4.11 OBSERVATION: The label "VOL" on the volume control is unnecessarily cryptic.

IMPACT: Although the abbreviation "VOL" would be easily understood by most trainees, the front panel offers ample space for the term "VOLUME," which may be an easier label for trainees with limited English language skills.

COMMENTS/POSSIBLE IMPROVEMENTS: Change "VOL" to "VOLUME."

4.12 OBSERVATION: Although the AUDIO 2 socket is used for "FILL" and "DATA" functions, it is not so labeled.

IMPACT: Analogous to that of Observation 4.10.

COMMENTS/POSSIBLE IMPROVEMENTS: See Comment, Observation 4.09.

4.13 OBSERVATION: The labels "Marconi," "SCIMITAR V," and "SER N° ¦______¦" are located on the front panel, although they provide no operational information to the operator.

IMPACT: These labels add clutter to the front panel.

COMMENTS/POSSIBLE IMPROVEMENTS: Move the labels to the top or a side panel.

Section 5: Connectors and Cables

5.01 OBSERVATION: The antenna connector is neither color- nor shape-coded for easy alignment.

IMPACT: Operators complained of having difficulty connecting the antenna, especially at night.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide tactile and color coding. Ensure that the design of the connector facilitates easy installation of the antenna without light.

5.02 OBSERVATION: The receptacles on the radio and the antenna tuning unit were not provided with protective caps.

IMPACT: The connectors are not protected from debris and moisture when not in use--especially noteworthy for the backpack configuration.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide caps that are easily installed and removed, will not interfere with operational and maintenance procedures, and are not easily lost.

5.03 OBSERVATION: The antenna/RFPA socket and the RFPA control connector on the rear panel of the vehicular applique unit are too close to each other.

IMPACT: One operator noted that the proximity of the receptacles makes it difficult to install the cables.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide more space between the sockets.

Section 6: Procedures

6.01 OBSERVATION: Adjusting the display brightness level requires the operator to manipulate three different controls.

IMPACT: The procedure is time-consuming and awkward.

COMMENTS/POSSIBLE IMPROVEMENTS: Such basic functions should be simple to control. Provide a dim control knob or other means of easily adjusting the brightness with one control.

6.02 **OBSERVATION:** The radio is not equipped with a keyboard.

IMPACT: The procedures for manually entering frequencies, key variables, etc. into the radio are very cumbersome, time-consuming, and error prone. For example, eleven steps are required to set and store a single frequency in the radio. Loading all six frequencies requires 66 steps.

COMMENTS/POSSIBLE IMPROVEMENTS: A simpler method of manually entering data into the radio would be desirable. A keyboard with number pad would greatly facilitate operations.

6.03 **OBSERVATION:** The clips for securing the battery and the ATU to the radio are cumbersome to fasten.

IMPACT: Installation of the battery and ATU is awkward and time-consuming.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide clips that can be fastened easily and quickly. (It should be noted that the clips, as they are, are easy to unfasten.)

6.04 **OBSERVATION:** The requirement to set the preset switch to "EXT" when preparing to enter data from a fill gun is puzzling: The fill gun is connected to the AUDIO 2 socket, but the "EXT" setting on the preset switch is described as controlling the function of the AUDIO 1 socket.

IMPACT: Operators and trainees might be confused, which would add to the training/retention burden.

COMMENTS/POSSIBLE IMPROVEMENTS: All operations should be explained (and labeled--see also Observation 4.01) so that they appear logical and are easily learned and remembered. (See comment for Observation 6.05.)

6.05 **OBSERVATION:** Because of inadequate labeling and display feedback, the operational procedures are frequently insufficiently aided by appropriate prompts and labels. The following example, which is the procedure for transferring time between nets, illustrates the point:

1. Set MODE switch on "RXS."
2. Ensure FUNCTION switch is not set on "FILL."
3. Set DISPLAY SETTING SWITCH to "P SET."
4. Select desired net with the PRESET switch. [Display now shows running time for that net.]
5. Press the LOAD/UP button. [Display blinks.]
6. Set PRESET switch to net whose time needs changing.
7. Set FUNCTION switch to "FILL." [Display shows "ErASE."]

8. Press the LOAD/UP button. [Display blinks.] (At this point the operator risks erasing all information stored in the radio. Caution must be exercised not to press the LOAD/UP and TEST/DOWN buttons at the same time.)
9. Repeat 6 to 8 for any other net that requires the same time.
10. To confirm time, set the FUNCTION switch to any position except "FILL."

IMPACT: The procedural steps just listed constitute a considerable learning/retention/recall burden, and there are almost no logical prompts in the process that assists the operator. Hence, in order for operators to perform this and other procedures effectively and efficiently, an inordinate amount of rehearsal, remedial practice or refering to the operator's manual is required.

COMMENTS/POSSIBLE IMPROVEMENTS: As a general rule, every control should be labeled for each of its functions, and there should be no functions that are not represented by labels or other appropriate machine prompt. (See also Observations 4.09, 4.10, & 6.04.) While the designers of a system may find its operational procedures inherently logical and self-evident because they understand the "inner-workings" of the system, it is very different for the operator whose training normally does not extend much beyond the superficial characteristics of the equipment.

(It must be added that there was no indication that this radio was difficult to learn to operate, relatively speaking. The procedural example described here, however, provides an indication that learning and retaining the information required to operate the radio could be made considerably simpler and easier.)

Section 7: Communication

7.01 **OBSERVATION:** Several operator comments indicated that there was some difficulty in communicating long range with the KY-57 (VINSON). (The precise nature of the problem is unknown.)

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.02 **OBSERVATION:** One operator noted: "When volume is on high, transmitting cannot be done without squeaking sound. When volume is lowered, squeaking stops."

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: The cause of the problem and its prevalence was undetermined.

7.03 **OBSERVATION:** One operator noted: "When vehicle was running, you could hear engine whirring in the handset."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Apparently the problem was not ambient noise. Electronic inference from vehicle systems should not occur.

7.04 **OBSERVATION:** One operator noted: "[The] radio [is] hard to hear while in intercom mode."

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: The cause of the problem and its prevalence was undetermined.

7.05 **OBSERVATION:** Two operator comments indicated the presence of an inordinate number of false cues. E.g., "The false cues . . . get pretty annoying after awhile."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: The cause of the problem was undetermined. Apparently it happened quite frequently, at least for this operator.

7.06 **OBSERVATION:** One operator noted: "Can't receive transmission when CUC [the vehicle] is keyed to intercom."

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: The cause of the problem was undetermined. Whether the failure resulted from inadequate operational knowledge or improper installation, or was due to an inherent radio characteristic was undetermined.

Section 8: Backpack Configuration

8.01 **OBSERVATION:** Several operators complained that the battery life for the backpack radio was insufficient, as was the supply of fresh batteries.

IMPACT: Lost or interrupted communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure an adequate supply of fresh batteries. Provide longer-lasting batteries.

8.02 **OBSERVATION:** The backpack configuration requires the attachment of an antenna tuning unit (ATU) between the radio and the battery.

IMPACT: The ATU is an additional piece of equipment that represents additional installation and logistical control procedures. In the backpack configuration, if a clamp screw came loose (perhaps a remote possibility), the ATU and battery could be lost. In vehicular installations the ATU must be removed and stored.

COMMENTS/POSSIBLE IMPROVEMENTS: Incorporate the function of the ATU into the radio.

8.03 **OBSERVATION:** Installation of the handle/antenna mount to the radio requires the use of a tool (screwdriver).

IMPACT: Tools can be misplaced or missing, resulting in operational delays. Tools also represent extra pieces of equipment that must be transported and accounted for.

COMMENTS/POSSIBLE IMPROVEMENTS: No operator-required tools should be needed for the assembly of any backpack radio components.

8.04 **OBSERVATION:** The backpack antenna clamp consists of four pieces, three of which are not integral to the radio and are easily removed.

IMPACT: The parts are prone to loss. If lost, communication would be difficult or impossible in some circumstances.

COMMENTS/POSSIBLE IMPROVEMENTS: All parts of the clamp should be captive.

8.05 **OBSERVATION:** The backpack radio antenna angle is controlled by an adjustable clamp. The base of the antenna is not flexible.

IMPACT: Adjusting the antenna angle is time-consuming and very awkward or impossible for the operator to perform while carrying the radio. Thus, the antenna would be prone to snagging in dense brush or undergrowth or other confined spaces, especially when the operator is crawling in the prone position.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a backpack antenna that has a flexible base, so that the angle of the antenna can be easily and quickly altered.

Section 9: Miscellaneous

9.01 **OBSERVATION:** The radio has an unexplained screw in the middle of the right side. The screw is easily removed and is not captive.

IMPACT: The screw is prone to loss.

COMMENTS/POSSIBLE IMPROVEMENTS: The significance of the screw was undetermined. Regardless, it should be captive.

9.02 **OBSERVATION:** The antenna tuning unit has an unexplained screw on the antenna-receptacle side. The screw is easily removed and is not captive.

IMPACT: Same as for Observation 9.01.

COMMENTS/POSSIBLE IMPROVEMENTS: Same as for observation 9.01.

9.03 **OBSERVATION:** The internal holding ("keep-alive") battery lasts approximately 10 hours with a full charge and takes approximately a day (24 hours) to fully recharge.

IMPACT: In vehicles, vehicle power is required to retain stored data for more than short periods of time; in the backpack radio, the main battery pack is required. Because of the relatively short life of the main battery (see Observation 8.01), the probability of losing stored data is magnified in the backpack configuration.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide an internal holding battery with longer life.

9.04 **OBSERVATION:** Two operator comments indicated some sort of incompatibility between the backpack configuration and the KY-57 (VINSON): (a) "Manpack needs to be redesigned for use with VINSON"; (b) "Need to find a way to hook up VINSON to backpack."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

9.05 **OBSERVATION:** The clip for hanging the handset was somewhat small and sharp.

IMPACT: Limited usefulness.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a larger, blunter clip.

9.06 **OBSERVATION:** The openings in the earpiece and mouthpiece of the handset appear to invite the collection of debris.

IMPACT: Possible damage or reduction of effectiveness of the handset.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide protective grillwork that resist the collection of debris in dirty environments.

9.07 **OBSERVATION:** Several operator comments indicated that the handset key was unreliable. It would frequently stick in the keyed position or otherwise fail to work properly.

IMPACT: The handset would frequently have to be struck against a solid object in order to unkey it. In some instances the handset would not work at all.

COMMENTS/POSSIBLE IMPROVEMENTS: Check the handset key design for reliability.

9.08 **OBSERVATION:** The handset cord is not coiled.

IMPACT: The cord gets tangled easily.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a coil cord.

9.09 **OBSERVATION:** The handset cord appears to have insufficient stress protection at the connector end.

IMPACT: The cord may be prone to wear or damage from repeated bending at the connector end.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a protective sleeve over the cord or otherwise increase resistance to abuse at the connector.

RACAL: DETAILED OBSERVATIONS

The following observations derive from two sources: (a) written comments of the 12 soldiers trained to operate the Racal radio; (b) the findings of two human-factors specialists who independently assessed the operator-radio interface characteristics of the radio. The "comments" and "possible improvements" are offered as suggestions only. They are not necessarily exhaustive, sufficient, consistent, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine.

Section 1: Operator's Manual

1.01 **OBSERVATION:** On a scale from -100 (poor) to +100 (good), the Racal operator manuals (backpack and vehicular configurations) were given the following scores by the reviewers (two human-factors specialists): Content (-19); Readability (-36); Illustration (-38); Durability (0). An overall mean of -24 was obtained by weighting the four areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean indicates that the manual was negatively evaluated in many areas. The following areas received negative evaluations: table of contents; general overview; operating instructions; troubleshooting procedures; subject index; safety hazards; type size; paragraph length; spacing; sentence length; reading level; content emphasis; number, proximity, and clarity of illustrations; and durability.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

1.02 **OBSERVATION:** The purpose of the screw head in the spare fuse holder is not explained in the manual.

IMPACT: Lack of operator knowledge. Unnecessary and perhaps undesirable exploratory activities on the part of the operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Explain the purpose in the appropriate section of the operator manual.

1.03 **OBSERVATION:** Poor organization of some material. Example: Instructions on operating the radio come before the programming instructions.

IMPACT: Increased learning time, confusion, and difficulty using the manual for reference purposes.

COMMENTS/POSSIBLE IMPROVEMENTS: Present material in a logical sequence whenever possible.

1.04 **OBSERVATION:** The manual is obviously not intended for the American soldier.

IMPACT: American soldiers may have difficulty adjusting to the British style of English. The manual would be a difficult to use in the classroom or field. One soldier offered the following comment: "If a person [were] to pick up the manual and not know anything about the operation of the radio, it would be very hard to self-instruct the operation of this radio. I feel that a person should be able to pick up a manual and be able to operate any piece of equipment in the armed forces. That manual might be the only instructor for you on the battlefield."

COMMENTS/POSSIBLE IMPROVEMENTS: The manual would have to be rewritten for the American soldier.

1.05 **OBSERVATION:** One soldier suggested that the manual needs to provide better coverage of PMCS ("Preventive Maintenance, Checks, and Services").

IMPACT: Possible insufficient care of radio and unnecessary referrals to higher level maintenance.

COMMENTS/POSSIBLE IMPROVEMENTS: Include a specific section devoted to the subject of PMCS.

Section 2: Operating Controls

2.01 **OBSERVATION:** With the exception of the keyboard, all controls on the front panel are very crowded. (See also Observation 5.1.)

IMPACT: The crowding causes considerable inconvenience to operators (as witnessed by their written comments). The proximity necessitates finger-tip manipulation of the controls, and the fingers tend to come into contact with connectors when the controls are manipulated. Operators complained that the controls are "hard to get to," and "hard to work," especially when the VINSON (KY-57) cables are installed or when the procedure entails depressing one of restriction-release buttons. The problem is likely to be significantly exacerbated when the operator must wear gloves (as with MOPP gear) or when the fingers are cold.

COMMENTS/POSSIBLE IMPROVEMENTS: Perhaps the small "IF" coaxial socket could be moved from the front panel or removed completely. The two remote terminals might also be located somewhere other than on the front panel. Decreasing the size of the keyboard, which is one of the best physical features of the panel, should be avoided. Expand the capability of the keyboard by adding other keys and functions to it.

2.02 **OBSERVATION:** The carry handle on the vehicular mounting tray barely clears the restriction-release button on the bottom of the radio.

IMPACT: The release switch is inordinately difficult to engage. The operator may find it difficult to zeroize the radio in an emergency

situation. The problem is worsened by the proximity of connecting cables.

COMMENTS/POSSIBLE IMPROVEMENTS: Move the release button to a more convenient location or incorporate the function into the channel switch by including pull-to-turn detents at appropriate positions of the switch.

2.03 **OBSERVATION:** The restriction-release buttons are difficult to depress, not only because of their locations, but also because of their design.

IMPACT: Slows operating procedures unnecessarily and provides a source of annoyance to operators. Operator comments noted that the switch can pinch or otherwise hurt the finger and that it might be "hard to disengage if you are wearing gloves or [your] hands [are] very cold."

COMMENTS/POSSIBLE IMPROVEMENTS: (Same as for Observation 2.02).

2.04 **OBSERVATION:** While depressing the restriction-release button in order to turn the channel switch to position "C" ("common code"), it would be relatively easy to overshoot the position and go into the "Z" (zeroize) position.

IMPACT: Possible danger of accidentally zeroizing the radio.

COMMENTS/POSSIBLE IMPROVEMENTS: Incorporate a pull-to-turn detent for the "Z" position of the channel switch.

2.05 **OBSERVATION:** The front panel controls knobs (volume, channel, and control switches) have pointed shapes, which is commendable.

IMPACT: The shape provides relatively unambiguous indication of switch settings, which is especially useful in low-light and from side views.

COMMENTS/POSSIBLE IMPROVEMENTS: Visual parallax distortion from side views could be improved by sloping the pointer toward the reference marks on the face of the panel. The switches could be improved even more by conforming to the design specified in MIL-STD-1472C.

2.06 **OBSERVATION:** The control switch had too much free play.

IMPACT: An annoyance, possibly indicating a quality control problem. Perhaps related to the following comment offered by one of the soldiers: "I think the cheap plastic that the switches are made of really wouldn't last too long in the infantry. They need to be either a stronger plastic or metal."

COMMENTS/POSSIBLE IMPROVEMENTS: Insure that quality materials are used.

2.07 **OBSERVATION:** The control switches have good detents (appropriate resistance), but they are noisy.

IMPACT: Possible security breach.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide switches that are minimally audible.

2.08 **OBSERVATION:** One operator commented that his volume control provided no variation in volume. The circumstances in which this observation was made are unknown.

IMPACT: Undetermined. (Possible complete loss of volume control. Possible relinquishing of control to ancillary equipment.)

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined. Volume control should always be available at the front panel of the radio. Control should not be relinquished to ancillary equipment.

2.09 **OBSERVATION:** The keyboard design is good. The keys are well-spaced and seem to provide adequate "feel." However, one operator disliked the feel; another felt that the keys might be problematic while wearing gloves; and another commented that the keyboard would be improved if there were a cover to protect it when not in use.

IMPACT: Estimated to be negligible.

COMMENTS/POSSIBLE IMPROVEMENTS: The extent to which the keyboard would be difficult to operate with gloves (arctic, NBC) and extent to which the keyboard requires a protective cover (especially in the backpack configuration) should be subjected to controlled experimentation. (The degree to which these matters were addressed during the development of this radio is unknown.)

2.10 **OBSERVATION:** The front panel controls (including the keyboard) are not illuminated for use in low-light or no-light situations. Operators appear to view this as a significant problem.

IMPACT: The lack of panel lighting makes it difficult or impossible for operators to manipulate the controls effectively in the dark without some sort of external light source, such as a flashlight, which may constitute a breach of security.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide back- or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

2.11 **OBSERVATION:** The P-T-T switch (pressel) on the handset is hard to depress.

IMPACT: Operators complained that after frequent use over an extended period of time their hands became fatigued and sore.

COMMENTS/POSSIBLE IMPROVEMENTS: Decrease the spring resistance on the switch.

Section 3: Display

3.01 **OBSERVATION:** The edges of the green LED display can be read from a maximum of approximately 50 degrees above, 47 degrees below, and 32 degrees to either side.

IMPACT: Readability from above and below is excellent, from the sides, fair.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, the display would allow viewing from about 45 degrees in all directions.

3.02 **OBSERVATION:** The display light is not subject to operator control (other than disable). Despite the automatic brightness control, the display is not bright enough in certain ambient-light situations (including moderate to low light), especially if there is any glare on the display window.

IMPACT: Operators expressed annoyance that they had no manual control of the display brightness. The lack of control could be a significant handicap: in certain ambient-light or light-discipline situations, manual control would be very desirable.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide manual control, either in place of or in addition to the automatic control.

3.03 **OBSERVATION:** Display window scratches easily and may be prone to damage from other physical abuse, especially in the backpack configuration.

IMPACT: Scratched or broken display window. (It is unknown to what extent the display window is resistant to breakage.)

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the display window is strong and sufficiently resistant to scratching. Consider providing a protective shield.

3.04 **OBSERVATION:** The display tends to be hard to read in direct sunlight.

IMPACT: Difficulty in programming.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide awnings (or equivalent) to shade the display.

3.05 **OBSERVATION:** The display is a green eight-digit LED, each digit limited to seven segments. It is therefore limited in the extent to which it can portray meaningful information to the operator, especially because of the seven-segment limitation. (See also Observation 3.06.)

IMPACT: Under the circumstances, the display resorts to new, unfamiliar, and uninterpretable symbols that require unwarranted learning and retention efforts on the part of the operator. For example, the display is incapable of portraying appropriate characters for the letters n, N, m, M, t, T, r, and R. As a result, inappropriate symbols are substituted.

COMMENTS/POSSIBLE IMPROVEMENTS: Incorporate a more versatile display capable of appropriately presenting all relevant information. Otherwise, maximize the meaningfulness of the current display by judicious selection of prompt and feedback symbology. One method of improving the display would be to provide an alternating display so that a greater number of display characters could be devoted to each message. For example, the display could alternate momentary presentations of the current frequency and the message "CLEAr" or "SECUrE." Avoid mixing numbers and letters in the same display message that are represented by the same symbol, such as 5's and S's. Avoid using the same or similar symbols to present different information.

3.06 **OBSERVATION:** Operators noted that the display symbology used in conjunction with the self-test facility was "not easy to remember." Similar symbology is used for representing different information.

IMPACT: Operators are burdened with increased learning and retention requirements, and may be confused during operation, especially if they do not operate the radio on a regular basis.

COMMENTS/POSSIBLE IMPROVEMENTS: See comment for Observation 3.05.

Section 4: Labels

4.01 **OBSERVATION:** The restriction-release buttons are not labeled and their locations are not immediately apparent from some normal operating positions.

IMPACT: They may be difficult for the new operator to locate, making procedures unnecessarily difficult. Emergency zeroizing may be impeded.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, relocate the buttons. Otherwise, employ labeling to indicate their locations.

4.02 **OBSERVATION:** Several of the keys on the keyboard have functions that are not indicated by appropriate labeling (e.g., the stepping key, 0, 7, and 9). One operator commented: "Some of the keys on the keypad do things which they aren't labeled to do. It gets confusing sometimes when it shouldn't be. Something needs to be done."

IMPACT: Operators are required to learn and retain the necessary information. If the associated functions are not used frequently, the correct procedures may be forgotten.

COMMENTS/POSSIBLE IMPROVEMENTS: All functions should be indicated by appropriate labels, without exception. This may entail appropriate physical or procedural redesign, as well as a modification of existing labels.

4.03 **OBSERVATION:** The label "T" on the keyboard is too cursory.

IMPACT: Unnecessary difficulty recalling meaning.

COMMENTS/POSSIBLE IMPROVEMENTS: Change label to "TEST," "TST," "CHK" (for "check"), or the like.

4.04 **OBSERVATION:** The label "A-R" on the keyboard refers to a procedure that in the U.S. Army is usually referred to as "retransmit" (or "retrans," for short). At any rate, the "A" in the label seems unnecessary.

IMPACT: Unfamiliarity with the term. Perhaps some difficulty learning or retaining it would result.

COMMENTS/POSSIBLE IMPROVEMENTS: Use "RE-B," "RE-T," "RXMT," or the like.

4.05 **OBSERVATION:** Three keys on the keyboard are devoted to the selection of transmit power level.

IMPACT: Space that is urgently needed to relieve the crowding and complexity of other controls is wasted.

COMMENTS/POSSIBLE IMPROVEMENTS: Use only one key for the power setting. Press once for "low," twice for "medium," and three times for "high."

4.06 **OBSERVATION:** The labels on the "VOL-ON/OFF" and "CHAN" switches are unnecessarily abbreviated. (See also Observation 4.07.)

IMPACT: Produces an unnecessary learning and retention burden on the operator and may interfere with the efficient operation of the radio, especially for soldiers who do not operate the radio on a regular basis.

COMMENTS/POSSIBLE IMPROVEMENTS: Change "F" to "FIXED," or "FF" ("fixed frequency"), "SC" ("single channel"), or the like. Change "H" to "F/HOP," "FH," "HOP," "H-ISEC" ("hop internal secure"), or the like. Change "B" to "BAR." Change "W" to "WSPR," or the like. Change "C" to "CC," "COM-C," or the like. Change "Z" to "ZERO."

4.07 **OBSERVATION:** The "VOL-ON/OFF" label on the so-called"volume switch" is not entirely appropriate because the switch is also used for other functions.

IMPACT: The obscurity of the labels "F," "H," "B," and "EXT S" is exacerbated. (See also Observation 4.06.)

COMMENTS/POSSIBLE IMPROVEMENTS: Use an expanded keyboard to select program functions.

4.08 **OBSERVATION:** The label "AUDIO" is not sufficiently associated, either spatially or graphically, with the audio sockets to which it refers. Spatially, it appears to be associated with the remote terminals.

IMPACT: Some confusion, especially on the part of the trainee, regarding the reference for the label.

COMMENTS/POSSIBLE IMPROVEMENTS: The label needs two reference lines, one pointing to the upper audio socket and one pointing to the lower.

Section 5: Connectors and Cables

5.01 **OBSERVATION:** The free space around the connectors on the front panel is very limited (see also Observation 2.01). (One operator commented that because the receptacles are on the right side of the radio, they are "out of the way," but another noted that a cable "runs across the radio when hooked to [VINSON KY-57] unit.")

IMPACT: In combination with the presence of connecting cables, the proximity of connectors, controls, and railings on the radio makes the installation and removal of plugs and the operation of controls difficult. Operators complained about the lack of easy access. Some operator comments: (a) "Cable connectors may be a little close to some other controls and may not always allow quick, easy access"; (b) "Cables make it hard to turn VOL-ON/OFF knob"; (c) "Finger space cramped"; (d) "Receptacles and cables are close to knobs [which] would cause trouble in operating them with cold weather gloves and NBC [gear]."

COMMENTS/POSSIBLE IMPROVEMENTS: (See Observation 2.01.)

5.02 **OBSERVATION:** Connector plugs and sockets are not conspicuously coded for easy alignment.

IMPACT: Making connections is too time-consuming and often a matter of trial and error.

COMMENTS/POSSIBLE IMPROVEMENTS: Employ shape and/or color coding on connectors.

5.03 **OBSERVATION:** The cap on the "IF" connector was extremely difficult to remove.

IMPACT: Operator frustration and delayed operations. The impact would normally be slight because the connector is rarely used (however, see Observation 5.04).

COMMENTS/POSSIBLE IMPROVEMENTS: Provide easily removable cap. (See comment for Observation 5.04.)

5.04 **OBSERVATION:** The retaining strap on the IF connector cap interferes with viewing the "REM" label on the control switch and physically interferes with the movement of the switch. If the strap is rotated out of the way, it then blocks the "IF" label.

IMPACT: Difficulty reading the control switch label and/or operating the switch. Operator frustration.

COMMENTS/POSSIBLE IMPROVEMENTS: Move the IF connector to another location or remove it altogether. Otherwise, redesign the cap and its retaining strap.

5.05 **OBSERVATION:** The plastic caps and stiff retaining straps on the audio connectors tend to interfere with access to the connectors.

IMPACT: The installation of plugs is hampered. Operators may permanently remove the caps because of the annoyance they cause.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide protective coverings that do not interfere with operations.

Section 6: Operational Procedures

6.01 **OBSERVATION:** Tone signals ("beeps") are used for a variety of purposes. These were some of the comments: "After a few days, the beeps drive you crazy"; (b) "A person gets tired of hearing a beep in his ear. It got to a point of even dreaming beeps in my sleep"; (c) "The beep is annoying because it beeps whenever you do something to the radio"; (d) "Sometimes beep is louder than voice message received, so it has a tendency of being extremely loud in one's ear"; (e) "Sometimes hard to remember the purpose of certain beeps."

IMPACT: While tone signals can be very useful (and important), their significance can be diminished if overused or used inappropriately, in which case their presence may become confusing or annoying or be ignored. The extent to which this radio misuses tone signals in unknown, but the operator comment above is indicative. Whether his annoyance derived from certain specific tones (such as the continual tones heard during secure modes of operation) is unclear.

COMMENTS/POSSIBLE IMPROVEMENTS: Determine the efficacy of the tone signals by subjecting the issue to controlled testing. Modify if warranted.

6.02 **OBSERVATION:** At certain times operators are required to wait specified amounts of time after depressing the P-T-T switch (pressel) before speaking.

IMPACT: Delayed communications. Enhanced probability of having to repeat a message. Increased transmission times. Operator annoyance.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

6.03 **OBSERVATION:** The zeroizing procedure, although basically simple, requires two hands to perform and is too complicated and indistinctive.

IMPACT: Operators may not remember the proper procedures, which require them to leave the channel switch in the "Z" position for at least 2 seconds (at least 10 with no supply power available), set the so-called "volume" switch to the appropriate setting <u>prior</u> to setting the channel switch, and, if no supply power is available, move the channel switch out of the "Z" position after 10 or more seconds to prevent discharging the internal backup battery.

COMMENTS/POSSIBLE IMPROVEMENTS: Simplify the zeroizing procedure so that a simple, discrete, two-step procedure ensures zeroizing under any circumstance and does not endanger the memory backup battery.

6.04 **OBSERVATION:** Access to the battery fuse requires a screwdriver, coin, or similar tool.

IMPACT: Possible significant delay in changing the fuse, with consequential interruption of communications.

COMMENTS/POSSIBLE IMPROVEMENTS: The fuse should be secured with a cap that can be installed and removed with the fingers.

6.05 **OBSERVATION:** Attaching the battery to the radio requires a time-consuming process of evenly screwing in two securing bolts. (See also Observations 6.06 and 9.08.)

IMPACT: Delay in changing battery, with consequential interruption of communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide clip fasteners.

6.06 **OBSERVATION:** The manual states: "The battery securing bolts have a wing nut combined with a coin slot for ease of tightening." However, the purpose of a wing nut is to obviate the need to use a tool. Despite the wing nuts, if the bolts are securely tightened, it is impossible to remove them without a tool. (See also Observation 6.05.)

IMPACT: Replacing the battery may require a tool--an unnecessary inconvenience that introduces considerable delay and consequential

interruption of communications. If the wing nuts are not securely tightened, however, they may accidentally loosen.

COMMENTS/POSSIBLE IMPROVEMENTS: Same as for Observation 6.05.

Section 7: Communication

7.01 **OBSERVATION:** The operators made many comments indicating that the radio was not adequately compatible with the VINSON (KY-57) equipment.

IMPACT: Excessive static, noise, or distortion or a total inability to communicate. Sometimes operators could receive but not transmit. Potentially serious safety/security hazard.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined. (See comment for Observation 7.02.)

7.02 **OBSERVATION:** According to repeated operator comments, it was impossible to achieve sufficiently high volume. Sample comments: (a) "The volume on the handset was extremely low. . . . I found myself too many times pressing the handset hard into my ear to understand the entire transmission"; (b) "Volume at its highest point is still too low when receiving transmissions"; (c) "While in or near vehicles running, the hand mic's volume is too low--it's muffled out."

IMPACT: The operators appeared to consider this a significant problem that made communicating difficult.

COMMENTS/POSSIBLE IMPROVEMENTS: The exact circumstances under which the problem of low volume was experienced are not known. One operator reported: "[When] talking through VINSON [KY-57], receiving station complained about low voice transmission." That comment suggests that the problem may have occurred primarily in conjunction with use of the KY-57. (See also Observation 7.01.)

7.03 **OBSERVATION:** Two comments (perhaps from the same operator) reported that the radio "kept receiving false hailing transmissions."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.04 **OBSERVATION:** Several comments complained of "noise," "static," and "screeching sounds" in the handset.

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.05 **OBSERVATION:** One operator offered this comment: "Radio transmitted poorly in rain (handset wet)."

IMPACT: Undetermined. (Operator rated it a "large" problem.)

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

Section 8: Backpack Configuration

8.01 **OBSERVATION:** Many comments were received attesting to the fact that the combination of this radio and the VINSON (KY-57) equipment is too heavy and too uncomfortable for the backpack configuration. One comment stated: "The makers of these radios should make them lighter in weight. We soldiers go through a lot in the field or combat. We don't need some heavy radio holding us down." (See also Observations 8.02 and 8.03.)

IMPACT: The soldier will not be able to effectively transport the equipment for long distances on foot. The added weight and discomfort may degrade the primary combat mission capability of the soldier.

COMMENTS/POSSIBLE IMPROVEMENTS: Forego the use of the KY-57 when it is expected that the soldier will have to carry the radio long distances on foot. The radio should be reexamined for ways to make it shorter and lighter.

8.02 **OBSERVATION:** The backpack frame was reported to be uncomfortable and too short. (The radio is relatively long with the battery installed.) One operator said: "The frame is too short or something; it [pushes] right into the operator's spine. It's hard to walk that way." (See also Observation 8.01.)

IMPACT: Same as for Observation 8.01.

COMMENTS/POSSIBLE IMPROVEMENTS: The frame should be reexamined for possible design improvements.

8.03 **OBSERVATION:** The backpack has plastic weight-bearing parts that are not strong enough. They are prone to breakage. (See also Observation 8.01.)

IMPACT: Dropped or, possibly, lost equipment. (According to one operator: "These pieces were too weak to hold the radio and the KY-57. They gave away within 1K of operation . . . [and] caused pain to man carrying [the] pack.")

COMMENTS/POSSIBLE IMPROVEMENTS: Strengthen the parts in question.

Section 9: Miscellaneous

9.01 **OBSERVATION:** The metal hanging clip on the handset appeared to be of poor design--perhaps too sharp, too narrow, and too weak. (Operators noted, however, that the handset itself was very strong.) One operator commented: "[The clip] isn't doing any good on the side. It should be on the back of the handset. It is not comfortable."

IMPACT: Possible inconvenience in using the clip. Possible breakage or damage. Possible injury to operator from sharp edges.

COMMENTS/POSSIBLE IMPROVEMENTS: Make the handset clip less sharp, wider, and more integral to the handset itself. Put the clip on the back of the handle.

9.02 **OBSERVATION:** The handset components, especially the P-T-T switch (pressel), seem overly exposed to debris and possible damage.

IMPACT: The P-T-T switch (pressel) could be blocked by debris. Handset may be taken apart too easily by the curious, which creates an unnecessary risk of damage or loss.

COMMENTS/POSSIBLE IMPROVEMENTS: Encase components so that they are integral to the handset and not attachments.

9.03 **OBSERVATION:** On the handset, the distance between the microphone and speaker may be too short.

IMPACT: Inconvenience for some operators.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the design meets the requirements of most operators (see MIL-STD-1472C).

9.04 **OBSERVATION:** The handset speaker and microphone are color-coded with bright colors.

IMPACT: An unnecessary feature that increases visibility of equipment from a distance.

COMMENTS/POSSIBLE IMPROVEMENTS: Remove color coding.

9.05 **OBSERVATION:** The handset cord is uncoiled and appears rather flimsy.

IMPACT: The cord tangles easily and may interfere with the operation of other equipment. It may also be vulnerable to physical abuse and ordinary "wear and tear."

COMMENTS/POSSIBLE IMPROVEMENTS: Provide strong, coiled cord.

9.06 **OBSERVATION:** The long antenna received many complaints. Among them: (a) "Difficult for long antenna to stay straight in an upright position because the antenna base is too flexible and is prone to break. [There is a] split/tear at bottom"; (b) "Antenna is too weak for field use--bends instead of sways"; (c) "The antenna is built too flimsy to take the punishment that comes in the field"; (d) "Antenna gets stuck when trying to disassemble."

IMPACT: Backpack operations/communications may be degraded or lost. Possible difficulty in stowing antenna.

9.07 **OBSERVATION:** The battery used for the backpack configuration rattles inside its housing.

IMPACT: An annoyance.

COMMENTS/POSSIBLE IMPROVEMENTS: Secure battery.

9.08 **OBSERVATION:** The backpack battery installation bolts have wing nuts that can extend beyond the side plane of the radio in the tightened position. (See also Observation 6.05.)

IMPACT: Radio may not rest evenly on its sides. An inconvenience.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide clip fasteners that are flush with the side panels.

9.09 **OBSERVATION:** The durability of the plastic casings on the equipment is unknown.

IMPACT: Possible degradation in cold or heat, especially when subjected to physical abuse.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

9.10 **OBSERVATION:** The radio has no carrying handles.

IMPACT: The lack of handles increases not only the difficulty in handling the equipment, but also the difficulty in securing it against theft. Furthermore, operators or maintenance personnel may tend to lift the radio by the handset cable, which has a rather long rubber tension relief at the connector end, thus exposing the cable to possible damage.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide adequate carrying handles.

ROCKWELL: DETAILED OBSERVATIONS

The following observations derive from two sources: (a) written comments of the 12 soldiers trained to operate the Rockwell radio; (b) the findings of two human-factors specialists who independently assessed the operator-radio interface characteristics of the radio. The "comments" and "possible improvements" are offered as suggestions only. They are not necessarily exhaustive, sufficient, consistent, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine.

Section 1: Operator's Manual

1.01 **OBSERVATION:** On a scale from -100 (poor) to +100 (good), the Rockwell manual was given the following scores by the reviewers (two human-factors specialists): Content (-19); Readability (+36); Illustration (+25); Durability (+50). An overall mean of +17 was obtained by weighting the four areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean, although positive, indicates considerable room for improvement. Areas receiving negative evaluations were the following: maintenance instructions, troubleshooting, subject index, safety hazards, content emphasis, illustrations, picture quality, and durability.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

1.02 **OBSERVATION:** It is assumed that the two audio connectors on the front panel of the radio are identical in function. The manual fails to make this clear to the operator.

IMPACT: The operator may be unsure about the usage of the connectors.

COMMENTS/POSSIBLE IMPROVEMENTS: Explain that the connectors may be used interchangeably or, if that is not true for all situations, explain any exceptions. Perhaps one of the connectors should be designated as an alternate both in the manual and in the labeling on the front panel.

1.03 **OBSERVATION:** The manual is frequently redundant. Two examples: (a) The instructions for conducting the BIT are the same for the backpack and vehicular configurations, yet they are repeated; (b) the introduction to frequency hopping for the backpack configuration is repeated verbatim (1 1/4 pages) for the vehicular configuration.

IMPACT: Repeated material must be carefully compared by the reader to determine that it is actually the same. This causes confusion, wasted time, and an unnecessarily lengthy document that is more difficult to learn from and use.

COMMENTS/POSSIBLE IMPROVEMENTS: Eliminate redundancy. Since the operational procedures are relatively simple, consideration should be given to combining the backpack and vehicular sections.

1.04 **OBSERVATION:** Information in the manual is poorly partitioned. Example: The "note" on page 12, because of its physical location, appears to belong to the BIT section. It really belongs to the following general procedures discussion.

IMPACT: Reader confusion.

COMMENTS/POSSIBLE IMPROVEMENTS: Insert appropriate headings and redesign the format to minimize possible confusion.

1.05 **OBSERVATION:** The manual contains no maintenance or troubleshooting sections.

IMPACT: Operators may be unaware of procedures for routine care of the radio. Problems encountered by the operator may be unnecessarily referred to higher-level maintenance. Problems may be incorrectly diagnosed or not diagnosed at all.

COMMENTS/POSSIBLE IMPROVEMENTS: Include appropriate information in manual.

Section 2: Operating Controls

2.01 **OBSERVATION:** The spring-loaded ("dead-man") display-light switch requires too much force to activate. (Tended to be viewed by soldiers as a significant problem.)

IMPACT: The switch hurts the finger when used repeatedly or held in the "on" position for any length of time. The problem would be exacerbated at night or in low-light situations. This problem increases the need for a secondary light source.

COMMENTS/POSSIBLE IMPROVEMENTS: Lessen spring tension on switch. Enlarge the knob. Provide locked "on" position (see Observation 6.01). Provide "on" with automatic shut-off after a few seconds.

2.02 **OBSERVATION:** Each control knob is retained by a single, non-captive, easily accessible Phillips-head screw.

IMPACT: An improperly tightened screw may vibrate loose. The knob and/or screw may be lost. (One soldier reported that a knob came off during the field exercise.)

COMMENTS/POSSIBLE IMPROVEMENTS: Retain knobs with two captive set screws spaced 90 degrees apart on side of knob.

2.03 **OBSERVATION:** The shape of the knobs on the volume control and function switch is symmetrical.

IMPACT: The shape does not provide unambiguous indication of switch setting, especially in low-light or dark, or from side angles of view.

COMMENTS/POSSIBLE IMPROVEMENTS: Use knobs that point, irrespective of any reference markings they may possess. The shape should minimize parallax distortion (normally achieved by sloping pointer toward the reference marks on the panel face). Conform to the design specifications presented in MIL-STD-1472C.

2.04 **OBSERVATION:** The cursor and column control knobs have no stops at either end of their ranges.

IMPACT: It is easy to overshoot the end of the range and thus find the cursor back at the beginning, or vice versa. This confuses new operators because the natural tendency is to expect the control to stop at either end of the range.

COMMENTS/POSSIBLE IMPROVEMENTS: Normally, this feature should be reserved for controls with long ranges where the control must be turned through several revolutions. For the short range through which the cursor and column controls travel, stops at both ends of the range would make it easier for operators to set the cursor.

2.05 **OBSERVATION:** The frequently used cursor and column controls are located on the left side of the front panel. Most operators are right-handed.

IMPACT: The controls may be slightly less convenient to operate than is necessary.

COMMENTS/POSSIBLE IMPROVEMENTS: Locate the VOL (volume) control to the left of the cursor and column controls; shift the latter controls to the right. (See also Observation 5.05.)

2.06 **OBSERVATION:** The "LITE" control, when rotated to the extreme right, caused the light to go out and the display to disappear.

IMPACT: Necessary to "back off" control slightly to maintain illuminated display. Possible annoyance to operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Prevent the switch from turning past the position that closes the light circuit.

2.07 **OBSERVATION:** The front panel controls are not illuminated for use in low-light or no-light situations. Operators appear to view this as a significant problem.

IMPACT: The lack of panel lighting makes it difficult or impossible for operators to manipulate the controls effectively in the dark without

some sort of external light source, such as a flashlight, which may breach security.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide back- or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

Section 3: Display

3.01 **OBSERVATION:** The edges of the display can be read from a maximum of approximately 26 degrees above, 34 degrees below, and 19 degrees to either side.

IMPACT: It is impossible to read the edges of the display from operating positions outside the described perimeter. It is possible to misinterpret characters, especially when viewing from above or from the sides.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, the display would allow viewing from about 45 degrees in all directions.

3.02 **OBSERVATION:** The LCD is difficult or impossible to read in certain common situations because of glare from ambient light. Use of the display illumination light does not appreciably affect the problem.

IMPACT: The operator must assume a relatively "straight-on" viewing angle in order to minimize glare, which is difficult or impossible to achieve from certain normal operating positions.

COMMENTS/POSSIBLE IMPROVEMENTS: Enlarge display window (but not character sizes) and incorporate awnings around window to reduce glare. Change to different kind of display that is less susceptible to glare.

3.03 **OBSERVATION:** While the display does indicate "NCS" for the net control station, it does not provide any indication for net member station status.

IMPACT: The new operator must remember that the absence of a station status indicator implies "net member station." To the new operator it may also erroneously imply that the status indicator is not working properly.

COMMENTS/POSSIBLE IMPROVEMENTS: Include a "net member station" identifier.

3.04 **OBSERVATION:** Display window scratches easily.

IMPACT: It is not known to what extent the display window would be subject to physical abuse. Perhaps the greatest impact, if any, would be on the backpack configuration.

ROCKWELL

COMMENTS/POSSIBLE IMPROVEMENTS: Provide scratch resistant display window.

3.05 **OBSERVATION:** The LCD is not capable of presenting certain characters ("B," "G," "M," "N," "R," "T," and "S") in a common format.

IMPACT: Operators (especially trainees) will experience at least temporary confusion between "8" and "B," and between "5" and "S" because in both cases the two characters are identical in the display. "G" may be confused with "6" because of their close similarity. "M," "N," "R," and "T" simply look strange, adding to the burden of the new trainee.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, adopt a more versatile display. Failing that, take care to maximize the limited capabilities of the current display. For example, instead of representing "battery" as "8AT," use "6AT." (On the current display, a "6" can adequately represent a lower-case "b," but an "8" cannot adequately represent an upper-case "B.")

Section 4: Labels

4.01 **OBSERVATION:** The label "HPA" is perhaps a misnomer. It is not "high power" that is being amplified, but simply "power." The "H" in "HPA" is not consistent with "HI," which is used to indicate "high power."

IMPACT: Possible temporary confusion for trainees.

COMMENTS/POSSIBLE IMPROVEMENTS: Use "LO" (low power), "HI" (high power), and "PA" (power amplifier).

4.02 **OBSERVATION:** The range line under the label "MODE" above the display lacks vertical end anchors to indicate the ends of the range. Because of crowding of labels above the display, the label "CHAN" extends into the area covered by "MODE," and "SQL" and "FREQ/NET/TIME" are not centered over their respective columns.

IMPACT: Some confusion for new trainees about which display columns belong to which labels may result.

COMMENTS/POSSIBLE IMPROVEMENTS: Space labels appropriately. Add anchors (as in |-----------|) to the line under "MODE." Add range line (with anchors) under "FREQ/NET/TIME." Perhaps divide display into sections (one for each label) separated by non-view-obstructing dividers.

4.03 **OBSERVATION:** The label "LITE" is an unnecessary corruption of "LIGHT."

IMPACT: Teaches incorrect spelling to soldiers who have minimal reading/writing skills.

COMMENTS/POSSIBLE IMPROVEMENTS: Use "LIGHT."

4.04 **OBSERVATION:** Labels are embossed.

IMPACT: Labels are prone to excessive wear, necessitating more frequent refurbishing.

COMMENTS/POSSIBLE IMPROVEMENTS: Use engraved rather than embossed labels.

Section 5: Connectors and Cables

5.01 **OBSERVATION:** The design of certain common plugs and sockets sometimes makes it physically difficult for operators to make connections quickly and easily, especially under adverse conditions (such as darkness, cold temperatures, wearing gloves, wearing NBC gear, etc.) There were some complaints about the difficulty of making cable connections with this radio.

IMPACT: The impact could vary from a mere annoyance to a serious, life-threatening problem, depending on circumstances.

COMMENTS/POSSIBLE IMPROVEMENTS: Use only connectors that can be shown to be easily and reliably used under a variety of adverse circumstances.

5.02 **OBSERVATION:** Connector plugs and sockets are not conspicuously coded for easy alignment.

IMPACT: Making connections is unnecessarily time-consuming and often a matter of trial and error.

COMMENTS/POSSIBLE IMPROVEMENTS: Employ shape and/or color coding on connectors.

5.03 **OBSERVATION:** The audio receptacle for the handset is too close to the protective corner post on the front panel.

IMPACT: It is quite difficult to make the connection and easy to hurt one's knuckle on the corner post. Difficulty of connection would be greater with gloves on.

COMMENTS/POSSIBLE IMPROVEMENTS: Move the connector away from the corner post.

5.04 **OBSERVATION:** A shorting cap for the power connector must be utilized for the backpack configuration. The cap is not securely attached to the radio.
IMPACT: A lost cap would totally disable communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Make the method of shorting the power connector integral to the radio and not dependent upon an ancillary part.

5.05 **OBSERVATION:** The antenna connection sometimes interferes with operation of the cursor control knob because of its proximity.

IMPACT: Makes cursor control awkward and more time consuming from some operating positions. The problem would be magnified if the operator were wearing gloves.

COMMENTS/POSSIBLE IMPROVEMENTS: Move cursor and volume controls to the right. (See also Observation 2.05).

5.06 **OBSERVATION:** The power connector is too close to the antenna connector.

IMPACT: Operator comments indicated some difficulty in making the antenna and power connections. The problem creates awkwardness and constitutes an avoidable loss of time that would be increased for operators wearing gloves.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase the space between power and antenna connectors.

5.07 **OBSERVATION:** The threads on the base of the antenna may be too fine.

IMPACT: Participants indicated problems of stripping the threads and difficulty installing the antenna.

COMMENTS/POSSIBLE IMPROVEMENTS: Use somewhat coarser threads and a center guide pin or other device to ease the connection.

5.08 **OBSERVATION:** The exposed antenna connector may be susceptible to physical damage.

IMPACT: Possible difficulty in connecting antenna. One operator felt that the track-vehicle environment could be especially hard on the connector.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide additional physical protection for the connector. Use a more rugged connector.

5.09 **OBSERVATION:** The backpack battery connector pins are poorly protected.

IMPACT: The pins, located at one end of the battery, are subject to damage when the battery is lifted off from the opposite end.

COMMENTS/POSSIBLE IMPROVEMENTS: Redesign battery housing or connector so that the battery cannot be removed improperly.

Section 6: Operational Procedures

6.01 **OBSERVATION:** Two hands are required to operate controls for conducting the self-test under low-light conditions.

IMPACT: Conducting the self-test may be very cumbersome, especially in the backpack configuration. The radio may have to be manually steadied by the operator while the controls are being manipulated. At the same time, the operator must activate (and hold) the display light switch and press the P-T-T switch on the handset. The procedure might also be quite awkward in the M151 vehicle.

COMMENTS/POSSIBLE IMPROVEMENTS: Eliminate the necessity of using the P-T-T switch during the self-test (perhaps substituting a "test" button on the front panel of the radio). Provide an optional feature that allows the display light to remain on for a limited time (see Observation 2.01).

6.02 **OBSERVATION:** It is necessary to operate two controls for selecting transmit power, mode, channel, squelch, frequency, net, and time.

IMPACT: Although the selection method used (cursor and column controls) saves panel space, it makes selections more cumbersome than would dedicated switches.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide keyboard control.

Section 7: Miscellaneous

7.01 **OBSERVATION:** The handles on the radio, while having the advantage of flexibility (which allows access to controls, etc.) appear to be quite flimsy. The attachments are rather easily bent.

IMPACT: Because the handles can be easily cut off, they provide only limited security when used for "tying down" the radio against theft. In addition, unnoticed damage to the handles might cause the radio to be dropped.

COMMENTS/POSSIBLE IMPROVEMENTS: Redesign the handles as integral parts of the radio housing.

7.02 **OBSERVATION:** The screws on the bottom panel of the radio are not captive.

IMPACT: The screws may be lost, especially during maintenance procedures.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide captive screws.

SEL: DETAILED OBSERVATIONS

The following observations derive from two sources: (a) the written comments of the 13 soldiers trained to operate the SEL radio and (b) the findings of two human factors specialists who independently assessed the operator-radio interface characteristics of the radio. The "comments" and "possible improvements" are offered as suggestions only. They are not necessarily exhaustive, sufficient, consistent with one another, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine.

Section 1: Operator's Manual

1.01 **OBSERVATION:** The official SEL manual was in German and therefore essentially unuseable for training or reference by U.S. soldiers. The official manual was not evaluated. The manufacturer provided instead photocopies of a series of charts (primarily in English) that illustrated in a perfunctory manner the characteristics and operation of the radio. The following assessment pertains to the latter document. On a rating scale ranging from -100 (poor) to +100 (good), the SEL manual was given the following scores by the reviewers (two human factors specialists): Content (+7); Readability (+7); Illustration (-29); Durability (-100). An overall mean of -19 was obtained by weighting the four content areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean indicated that the instructional document was considered fair to poorin most respects. Areas receiving negative evaluations were: maintenance instructions, troubleshooting, subject index, safety hazards, type size, margins, and picture quality.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly. (It is assumed that an official manual, translated into U.S. English would be provided if requested.)

1.02 **OBSERVATION:** The documentation provided had no adequate table of contents or index.

IMPACT: It was difficult to locate specific information quickly.

COMMENTS/POSSIBLE IMPROVEMENTS: The documentation would have been more useful if an adequate table of contents or an index had been provided.

Section 2: Operating Controls

2.01 **OBSERVATION:** The knobs on the front panel were small, closely situated with other controls, and difficult to turn, as attested to by many operator comments. (See also Observation 2.02, Impact.)

IMPACT: As a result of their shape, proximity, and surface texture, the knobs (especially those that were round) were difficult to turn. The problem worsened if the fingers were slippery (as with perspiration) or cold. Operator comments: (a) Hard to operate with wet fingers or with gloves on"; (b) "Switches hard to turn when fingers are wet and cold"; (c) The frequency-changing switches are too small and too close together, and that makes it hard to change [them], especially when your hands are cold or when wearing gloves"; (d) "Cannot change knobs (they are too small with gloves on)"; (e) "Knobs are hard to turn"; (f) "For AKW, the group # and net # switches are hard to turn. Also they are too close to one another"; (g) "Group and net number knobs are too close to turn and are also very stiff. Also, fingers slip when wet or sweaty"; (h) "I feel that the group # knob and the radio net knob [are hard] to turn"; (i) "The knobs for adjusting frequencies [in the] HW mode and AKW were too close together"; (j) "The knobs that changed the frequencies were hard to turn when fingers were cold and wet"; (k) "Knobs are almost impossible to use with gloves on"; (l) "[The controls are] hard to turn and are too close together"; (m) "Need to make the knobs a little bigger."

COMMENTS/POSSIBLE IMPROVEMENTS: About 25% of the front panel space is occupied by the frequency memory module. Whether it would be feasible to move the memory module to a different surface (thus alleviating the crowding on the front panel) was undetermined. The four control knobs for setting the group and net numbers also occupy approximately 25% of the panel space. It might have been better to combine these controls into one (see Observation 6.03). Provide better knurling on all knobs and decrease their rotational resistance in order to prevent finger slippage. Additional panel space would allow control knobs to be enlarged for easier finger manipulation.

2.02 OBSERVATION: Two controls are required for setting frequencies. (See also Observation 6.02.)

IMPACT: Using two controls where one might suffice (see also Observation 2.02, Comment & Observation 6.03) unnecessarily crowds the front panel, making manipulation of controls difficult, especially in adverse conditions (such as cold weather, when the operator is likely to be wearing gloves).

COMMENTS/POSSIBLE IMPROVEMENTS: One knob that controls MHz when rotated one way and kHz when rotated the other way (see Observation 2.01, Comment) might suffice.

2.03 OBSERVATION: When the frequency-selection controls are activated, the frequency numbers do not stop at the ends of the frequency range, but cycle immediately from top to bottom, or vice versa, and start over again.

IMPACT: The operator is likely to overshoot the end of the ranges when selecting frequencies. One operator commented: "When setting [the]

frequency, there is a tendency to over- or undershoot the frequency at the ends of the range. Should stop at 30.000 [and 79.975] and not continue to go around the spectrum."

COMMENTS/POSSIBLE IMPROVEMENTS: The advantage of the cycling method (being able to switch very rapidly from the top to the bottom or from the bottom to the top of the frequency range) is sometimes lost by the annoying distraction of overshooting or undershooting the desired setting. The severity of the problem is partially determined by the speed with which the frequencies are scrolled by during selection, faster speeds making over- or undershooting more likely. A two-speed control that stopped (at least temporarily) at both ends of the range would greatly reduce the problem.

2.04 **OBSERVATION:** Each control knob is retained by a single, non-captive, easily accessible, blade-head screw. (See also Observations 2.10 & 8.03.)

IMPACT: Improperly tightened screws may vibrate loose, or they may be loosened by curious operators. As a result, the knob and screw may be lost.

COMMENTS/POSSIBLE IMPROVEMENTS: Retain knobs with two captive set-screws spaced 90 degrees apart on the side of the knob.

2.05 **OBSERVATION:** The transmitter power and mode selection knobs are not properly keyed for installation.

IMPACT: Both of these knobs can be installed 180 degrees from their proper orientation.

COMMENTS/POSSIBLE IMPROVEMENTS: All control knobs should be keyed so that they must be installed correctly.

2.06 **OBSERVATION:** The knobs for controlling transmitter power and mode selection are symmetrical.

IMPACT: The shape of the knobs does not provide unambiguous indication of switch settings, especially in low-light or dark or from side angles of view.

COMMENTS/POSSIBLE IMPROVEMENTS: Use knobs with shapes that point, irrespective of any reference markings they may possess. The shape should minimize parallax distortion (normally achieved by sloping the pointer toward reference marks on the face of the panel). Conform to the design specifications presented in MIL-STD-1472C.

2.07 **OBSERVATION:** The control knobs appear to be of plastic construction.

IMPACT: The durability of the spindle/knob junctures is questionable; they are possibly prone to premature wear.

SEL

COMMENTS/POSSIBLE IMPROVEMENTS: Metal-to-metal contact between the control knobs and their spindles may be more appropriate.

2.08 **OBSERVATION:** The channel-spacing/pilot-tone control requires the use of a tool.

IMPACT: The control is very unhandy and time consuming to use. Operations may be adversely impacted if the operator does not have a tool (such as a screwdriver or coin immediately available.

COMMENTS/POSSIBLE IMPROVEMENTS: No operational controls should require the use of a tool. Change the present slotted control to a knob that can be easily set with the fingers.

2.09 **OBSERVATION:** One operator noted: "Loudness of speaker could not be controlled with the volume control knob."

IMPACT: The precise nature of this problem was undetermined. However, if the situation is such that the operator cannot control the speaker volume in _any_ way, then the volume may be too low (which would interfere with communications) or too high (which might breach security).

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the volume can be appropriately controlled.

2.10 **OBSERVATION:** The cover on the push-button for the frequency display button is easily removed. (See also Observations 2.04, 8.02, & 8.03.)

IMPACT: The cover is prone to loss.

COMMENTS/POSSIBLE IMPROVEMENTS: All covers, controls, screws, etc. on the external surface of the radio should be captive.

2.11 **OBSERVATION:** The radio has no power-on lamp.

IMPACT: There is no visual confirmation that power is present in the unit.

COMMENTS/POSSIBLE IMPROVEMENTS: A power-on lamp would be useful in the vehicular configuration for trouble-shooting and as a reminder to turn off the power at appropriate times.

2.12 **OBSERVATION:** Release of the push-to-talk button on the handset, even at low volume, produces a loud noise in the earphone. (See also Observation 2.13.)

IMPACT: The noise may be loud enough to be harmful to the ear.

COMMENTS/POSSIBLE IMPROVEMENTS: Whether this was an isolated event (i.e., pertaining to one handset or one radio only) was undetermined. If the problem is customary, it should certainly be rectified.

SEL

2.13 **OBSERVATION:** One operator reported that "a loud screeching noise [is heard] when volume is all the way up."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Whether this problem was an isolated occurrence or related to Observation 2.12 is unknown. If found to be pervasive, it should be corrected.

2.14 **OBSERVATION:** The front panel controls are not illuminated for use in low-light or no-light situations. Operators view this as a significant problem.

IMPACT: The lack of panel lighting makes it difficult or impossible for operators to manipulate the controls effectively in the dark without some sort of external light source, such as a flashlight, which may breach security.

COMMENTS/POSSIBLE IMPROVEMENTS: Consider providing back-lighting or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

Section 3: Display

3.01 **OBSERVATION:** The edges of the display can be read from a maximum of approximately 33 degrees above, 27 degrees below, 28 degrees to the left, and 21 degrees to the right.

IMPACT: It is impossible to read the edges of the display from operating positions outside the described perimeter. It is possible to misinterpret characters, especially at the ends of the display.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase viewing angles from all sides. Ideally, the display would allow viewing from about 45 degrees in all directions.

3.02 **OBSERVATION:** The display light button provides only momentary lighting of the LED--except when setting frequencies, when there is a five-second delay before the display turns off.

IMPACT: Normally the operator does not need the display to be lit for any extended period. Occasionally, however, the lack of a delayed display-off feature may be frustrating to operators.

COMMENTS/POSSIBLE IMPROVEMENTS: Whether the advantages of a delayed display-off feature (at times when data are not being loaded) outweigh the advantages of the immediate-off feature (security, battery life) is unknown.

3.03 **OBSERVATION:** The display is a five-character LED with each character limited to seven segments. The display is therefore limited in the extent to which it can portray meaningful information to the operator, especially because of the seven-segment limitation.

IMPACT: The display is incapable of portraying appropriate characters for the letters a, B, D, e, f, g, G, j, k, K, m, M, n, N, p, q, Q, r, R, s, t, T, v, V, w, W, x, X, y, Y, z, and Z. Furthermore, 5 and S look the same, as do 6 and b and 0 (zero) and the letter O. The potential of the display for providing prompts and feedback to the operator is not maximized.

COMMENTS/POSSIBLE IMPROVEMENTS: A more versatile display could enhance training, operation, testing, and troubleshooting of the radio and partially obviate the necessity for a separate test device.

Section 4: Labels

4.01 **OBSERVATION:** There were many operator comments indicating dissatisfaction with the absence of English labeling on the radio.

IMPACT: Learning and retention of operational procedures was undoubtedly negatively affected by the lack of English terminology. The absence of English labels also precluded assessment of the appropriateness of most of the labeling.

COMMENTS/POSSIBLE IMPROVEMENTS: A panel overlay with English labels would have alleviated the problem during the assessment period.

4.02 **OBSERVATION:** The labels "34," "38," and "39" are unnecessarily large and uninformative.

IMPACT: Numerical labels such as these convey no inherent meaning to the operator. Hence, the operator is forced to learn and remember the purpose of the associated radio features without mnemonics provided by the labeling.

COMMENTS/POSSIBLE IMPROVEMENTS: Normal operational labels should provide a clear indication of the purpose of the controls they identify. Thus, for example, the label "38" should be an alphabetical word such as "AUDIO" or "HANDSET" or other appropriate term or easily understood abbreviation.

4.03 **OBSERVATION:** The labeling for the channel-spacing/pilot-tone control switch is rather abstruse.

IMPACT: The proper use of the control may not be readily grasped or easily retained by the trainee.

COMMENTS/POSSIBLE IMPROVEMENTS: Something like the following would be an improvement:

```
      25              50
          •       •
            \
             \
          •       •
      25              50
   (w/150Hz)       (w/150Hz)
```

4.04 **OBSERVATION:** The high-power label reference mark is a large red dot.

IMPACT: The mark is barely visible in low light, and may be especially difficult to see by color deficient operators.

COMMENTS/POSSIBLE IMPROVEMENTS: Use of the colors red and green should be avoided in labels. Use high contrast symbols (e.g., white) where visibility is important in low-light situations.

Section 5: Connectors and Cables

5.01 **OBSERVATION:** When installing the protective rubber caps on receptacles between the labels "39" and "38" on the left side of the radio, the caps trap air inside.

IMPACT: When the fingers are removed from the caps after the caps are installed, the compressed air inside the caps causes them to back off the receptacle about halfway.

COMMENTS/POSSIBLE IMPROVEMENTS: Use plastic or metal caps or an otherwise altered design to ensure that the caps remain in their completely installed positions when released.

5.02 **OBSERVATION:** Several of the protective caps on the radio and ancillary equipment are secured with cords that are not well attached.

IMPACT: The cords can be torn away easily.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide durable attachments for protective caps. The attachments should not interfere with either operational or maintenance procedures.

5.03 **OBSERVATION:** Three operator complaints noted that certain connectors were hard to install: (a) "[The] antenna cable to radio is too hard to install because of the lack of room. Also, while using the DMD [there is not enough room for] the connector that goes on by the connector of the mic"; (b) "There should be more room for your fingers on the antenna connection"; (c) "The antenna cable is difficult to connect because of its position."

IMPACT: Operators waste time wrestling with crowded connectors and controls, especially when working in adverse weather conditions. (See also Observation 2.01.)

COMMENTS/POSSIBLE IMPROVEMENTS: All controls and connectors should be adequately spaced for ease of use in all anticipated operational conditions. Alleviation of crowding can be achieved in equipment developmental phases by combining related controls, judiciously locating controls, connectors, and other features, and utilizing space-saving designs.

5.04 **OBSERVATION:** The handset has a very sturdy coiled cord; but at the male end (handset end), the protective ring around the connector pins is quite thin.

IMPACT: The protective ring appears prone to easy damage.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the ring will withstand the abusive treatment it might be expected to receive on the battlefield or in field exercises.

5.05 **OBSERVATION:** The handset cable must be connected by the operator to the handset as well as to the radio.

IMPACT: The non-integrated cable requires operators and supply personnel to keep track of two items of equipment instead of one. The operator is also forced to perform an additional operational procedure.

COMMENTS/POSSIBLE IMPROVEMENTS: The cable is always required for operation; therefore, it should probably be an integral part of the handset, with a connector at the radio end only.

5.06 **OBSERVATION:** One operator commented that the handset cable should be a little longer.

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

Section 6: Operational Procedures

6.01 **OBSERVATION:** Three operator comments noted that the radio has no capability for storing alternate preset frequencies for single-channel operation: (a) "There are no presets on this radio; that is the most important thing . . . that it does not have. In combat you would need to change frequencies in seconds"; (b) "Changing frequencies manually every time takes too much time and energy. If [the SEL radio] is to replace [the] VRC 12 series, it should have presets"; (c) "This radio has no presets, which makes it impossible for it to even compete with a VRC 12 series."

IMPACT: Without presets, the operator consumes much time changing frequencies in single-channel operation. The problem is made worse by the considerable difficulty of changing frequencies (see Observation 6.02).

COMMENTS/POSSIBLE IMPROVEMENTS: Provide preset frequency capability.

6.02 **OBSERVATION:** The MHz and kHz frequency-setting control knobs are very difficult to turn and may require many rotations.

IMPACT: Setting single-channel ("manual") frequencies is inordinately time consuming, which, combined with the lack of stored preset frequencies (see Observation 6.01), may constitute a significant problem in operational situations where time is crucial.

COMMENTS/POSSIBLE IMPROVEMENTS: The setting of single-channel frequencies should be able to be accomplished quickly and easily. The use of one easily manipulated control rather than two would help (see Observation 2.02).

6.03 **OBSERVATION:** Selecting group and net numbers requires the use of four different control knobs.

IMPACT: The procedure is overly complicated and requires the use of much panel space. (See also Observations 2.01 & 2.02.)

COMMENTS/POSSIBLE IMPROVEMENTS: These functions could perhaps be accomplished with one control instead of four: A single control could scan through group numbers when turned counterclockwise and through net numbers (either rapidly or slowly, depending on how far the control were rotated) when turned clockwise; or two controls could be utilized by having one for the group numbers (as now) and one for the net numbers. Fewer controls permits larger, more easily manipulated controls.

Section 7: Communication

7.01 **OBSERVATION:** It was reported that while operating the radio test device in a tank, a "3" was observed in the test display both for the emission-free and the emitted-power checks. Nevertheless the radio would receive and transmit with no problems.

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.02 **OBSERVATION:** Two operator comments pertained to communications in conjunction with the digital message device (DMD): (a) "While transmitting with the DMD in the frequency-hopping [AKW] mode, the receiving station would receive the message, but the transmitting station would

not get acknowledgement that the receiving station gets the message"; (b) "In the AKW mode of operation, DMD would not work at all."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

Section 8: Miscellaneous

8.01 **OBSERVATION:** One operator suggested that the radio needs a "flashing light, buzzer, etc. when there is an incoming call." (See also Observation 2.09.)

IMPACT: In the absence of an external speaker or in a noisy environment in which the speaker is inaudible, the operator might not be aware of the incoming communication.

COMMENTS/POSSIBLE IMPROVEMENTS: A signal such as that suggested would alert the operator to use a handset or headset.

8.02 **OBSERVATION:** The push-button caps on the left side of the antenna matching unit [AT-70] and on the battery are easily unscrewed and are not captive. (See also Observations 2.04, 2.10, & 8.03.)

IMPACT: These caps are prone to loss.

COMMENTS/POSSIBLE IMPROVEMENTS: Same as for Observation 2.10.

8.03 **OBSERVATION:** The retaining screws for the frequency-memory module cover are not captive. (See also Observations 2.04, 2.10, & 8.02.)

IMPACT: The screws may be lost.

COMMENTS/POSSIBLE IMPROVEMENTS: Same as for Observation 2.10.

8.04 **OBSERVATION:** The frequency-memory module is retained by two non-captive, knurled, slotted screws. (See also Observation 8.03.)

IMPACT: If the screws are not tightened adequately or evenly, the cover seal may leak, allowing water or other substances to enter the memory module compartment and possibly damage the module.

COMMENTS/POSSIBLE IMPROVEMENTS: Leaks are prevented only by the diligence of the operator or maintainer, which constitutes an undue risk. The module cover should be retained by a method that does not require significant care during installation--perhaps clips instead of screws.

8.05 **OBSERVATION:** The radio has no carry handles.

IMPACT: The radio is awkward for installers and maintainers to handle and is more difficult to secure against unauthorized removal in vehicular installations.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide handles that can serve also as a means for securing the radio.

8.06 **OBSERVATION:** The right and left sides of the radio have various uneven protrusions.

IMPACT: The radio cannot be stood on either side, which may be inconvenient during maintenance or in other situations.

COMMENTS/POSSIBLE IMPROVEMENTS: As a general rule, uneven projections from all surfaces should be minimized. (Projections should also be protected from damage that may result from resting the equipment with the projection underneath, resting other objects on the equipment, or accidental impact from dropping or from another object.)

8.07 **OBSERVATION:** One operator complained that the earpiece on the handset was uncomfortable.

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

8.08 **OBSERVATION:** The rubber-like covering on the handset appears flimsy. Operator comments: (a) "Handset needs to [have] the casing a little harder"; (b) "Need to make the handset shell harder."

IMPACT: Whether the external covering of the handset would withstand the abuse expected from prolonged battlefield environments and field exercises is not known.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the covering is durable.

8.09 **OBSERVATION:** The diaphragm of the handset earpiece is exposed to abuse.

IMPACT: The diaphragm can be easily torn, cut, poked, etc.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide an earpiece that is better protected from injury.

8.10 **OBSERVATION:** The handset earpiece and mouthpiece are easily dismantled. The mouthpiece comes apart into four non-captive pieces. When the screw on the earpiece is removed (five turns only), there are three non-captive parts.

IMPACT: All of these parts may be easily lost or damaged in field settings.

COMMENTS/POSSIBLE IMPROVEMENTS: The handset is an object that is likely to be disassembled at one time or another by the curious operator or for field maintenance purposes such as cleaning out accumulated dirt or other debris. Therefore, all parts should be durable and captive.

8.11 **OBSERVATION:** The backpack radio weighs approximately 4.9 kg (10.8 lbs).

IMPACT: Although not heavy by comparison standards, the radio does constitute a significant burden when considered along with other equipment that the soldier may carry.

COMMENTS/POSSIBLE IMPROVEMENTS: Every effort should be exerted to make soldier-portable radios as small and light as possible.

TADIRAN: DETAILED OBSERVATIONS

The following observations derive from two sources: (a) the written comments of the 12 soldiers trained to operate the Tadiran radio and (b) the findings of two human factors specialists who independently assessed the operator-radio interface characteristics of the radio. The "comments" and "possible improvements" are offered as suggestions only. They are not necessarily exhaustive, sufficient, consistent with one another, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine.

Section 1: Operator's Manual

1.01 **OBSERVATION:** Three Tadiran manuals were evaluated: the "Operator and Organizational Maintenance Manual" for Radio Set PRC-80 (OM 2051-09500-00, April 1982), the "Operator and Organizational Maintenance Manual" for Radio Set VRC-8000 (OM 2051-09510-00, April 1982), and the "Operator Manual" for ECCM Unit CPA-9008 (OM 2342-09512-00). Because the three manuals were similar in format and presentation, the results represent a compilation of the assessments of all three documents. On a rating scale ranging from -100 (poor) to +100 (good), the Tadiran manuals were given the following scores by the reviewers (two human factors specialists): Content (+25); Readability (-36); Illustration (-13); Durability (-100). An overall mean of -22 was obtained by weighting the four content areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean indicated that the manuals were considered fair to poor in most respects. Areas receiving negative evaluations were: general overview, specifications, subject index, safety hazards, paragraph length, spacing, sentence length, reading level, emphasis, number of illustrations (too few), proximity of illustrations, clarity of illustrations, and durability.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

1.02 **OBSERVATION:** The manuals include both operating and organizational maintenance instructions.

IMPACT: The manuals are inefficient in that they contain material not needed by both operators and maintainers. Operators and maintainers who work with both the PRC-80 and the VRC-8000 require two manuals.

COMMENTS/POSSIBLE IMPROVEMENTS: Consideration should be given to combining the operating instructions from the three manuals into a single document for operators. Likewise, the organizational maintenance instructions could be combined into a single maintenance manual.

1.03 **OBSERVATION:** The manuals have no indexes.

IMPACT: It is difficult for operators and maintainers to locate specific information quickly.

COMMENTS/POSSIBLE IMPROVEMENTS: Although they have tables of contents, the manuals would be improved significantly with the addition of complete indexes so that users could locate information by keywords rather than by topic.

1.04 **OBSERVATION:** The manual notes that the display response time in cold temperatures is longer than normal.

IMPACT: The operator is required to "hold the LIGHT control ON for a few seconds until the display responds properly." The manual does not provide guidelines that tell the operator what to expect under various temperature conditions. The extent to which this might constitute an operational problem or inconvenience was not determined.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide additional information in the manual.

1.05 **OBSERVATION:** The Operator Manual for the ECCM Unit (CPA-9088) does not describe emergency memory erase procedures adequately. (This may also be true for documentation associated with the communication security unit, SEC-8088, which was not provided for evaluation.) (See also Observation 4.09.)

IMPACT: Operators who learn from the manual are likely to be confused about the correct procedures; they may erase information (or fail to erase information) accidentally.

COMMENTS/POSSIBLE IMPROVEMENTS: The term "save" (ECCM manual, pp. 3-2 & 3-9) may be misleading. The reader's natural response to the term within its context is to interpret it as referring to the unit's internal memory. Upon consideration, however, it appears to refer to the memory backup battery; i.e. the "SAVE" position on the MODE switch seems to imply "save the battery" rather than "save the memory." The distinction is, of course, an important one. Furthermore, the first statement in paragraph 3-7 (p. 3-9) confounds the issue--it appears to be erroneous. The statement should imply that stored data can be erased even when external power <u>is being applied</u> rather than when "no power source is available." Basically, the problem is that the manual descriptions are confusing and possibly erroneous; they should be revised.

1.06 **OBSERVATION:** The antenna mast section (AT-2808) is described in the manual (p. 1-9) as consisting of five elements. Actually, there appear to be only four.

IMPACT: Possible operator confusion.

COMMENTS/POSSIBLE IMPROVEMENTS: Correct the manual.

Section 2: Operating Controls

2.01 **OBSERVATION:** The radio has no power-on lamp.

IMPACT: The is no visual confirmation that power is present in the unit.

COMMENTS/POSSIBLE IMPROVEMENTS: A power-on lamp would be useful in the vehicular configuration for trouble-shooting and as a reminder to turn off the power at appropriate times.

2.02 **OBSERVATION:** The front panel controls are not illuminated for use in low-light or no-light situations. Operators view this as a significant problem.

IMPACT: The lack of panel lighting makes it difficult or impossible for operators to manipulate the controls effectively in the dark without some sort of external light source, such as a flashlight, which may breach security. One operator commented: "The keypad is too hard to see in low light."

COMMENTS/POSSIBLE IMPROVEMENTS: Consider providing back-lighting or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

2.03 **OBSERVATION:** Except for the frequency offset switch, the control knobs on the radio's main units are symmetrical (either round or elongated).

IMPACT: Although the knobs are coded (with white paint) to indicate the pointing direction, the shapes do not provide unambiguous indication of switch settings, especially in low-light or dark or from side angles of view. If groves containing the white paint became dirty, or if the paint wore off, it would be difficult for the operator to read the correct positions of the knobs--especially on switches like the channel selector and volume control (which have many possible settings that cover nearly a full circle). The shape of the knobs creates visual parallax that makes it difficult to read settings accurately from less than optimal viewing angles.

COMMENTS/POSSIBLE IMPROVEMENTS: Use knobs with shapes that point (such as on the offset switch), irrespective of any reference markings they may possess. The shape should minimize parallax distortion (normally achieved by sloping pointer toward reference marks on panel face). Conform to the design specifications presented in MIL-STD-1472C.

2.04 **OBSERVATION:** Each control knob is retained by a single, non-captive, easily accessible Phillips-head screw. The screws also have non-captive lock washers.

IMPACT: An improperly tightened screw may vibrate loose or be removed by operators. Knobs, screws, and washers may be lost.

COMMENTS/POSSIBLE IMPROVEMENTS: Retain knobs with two captive set screws spaced 90 degrees apart on side of knob.

2.05 **OBSERVATION:** The control knobs can be installed 180 degrees from their proper orientation.

IMPACT: The knobs may be accidentally installed backwards, creating confusion or the impression that a switch is faulty.

COMMENTS/POSSIBLE IMPROVEMENTS: As a general rule, it should be impossible to install components improperly. They should be keyed to fit only in the proper position.

2.06 **OBSERVATION:** Access to the display light switch is limited because of its proximity to the antenna base.

IMPACT: The control is sometimes difficult to operate.

COMMENTS/POSSIBLE IMPROVEMENTS: Perhaps the location of the switch could be exchanged with that of a less often used switch such as the offset or mode switch.

2.07 **OBSERVATION:** The light switch on the radio examined did not function properly.

IMPACT: The switch would activate the display but would not return to the "NORM" position--apparently because of an impaired spring load.

COMMENTS/POSSIBLE IMPROVEMENTS: Whether the problem was an isolated event or typical of the radios was not determined. It should be ensured that the design of the switch makes the problem highly improbable.

2.08 **OBSERVATION:** The power switch is a multiple purpose switch without corresponding detents that distinguish the separate functions. (See also Observation 4.02.)

IMPACT: One operator noted that it was "easy to overshoot" power settings on the power switch. Presumably, then, it would be possible for an operator who hurriedly sets the switch, to unintentionally and unknowingly move the switch to "RMT" or "RCV."

COMMENTS/POSSIBLE IMPROVEMENTS: Normally, when a switch has more than one function, a stop or strong detent should be placed between different functions--here, between "RCV" and "LO" and between "HI" and "RMT."

2.09 **OBSERVATION:** The offset control knob was the subject of much operator criticism. Although the knob is pointed (and thus overcomes the objection expressed in Observation 2.03), it is crowded and its shape is not conducive to easy gripping.

IMPACT: The knob provides poor finger access and control, especially in adverse conditions such as cold weather (when the operator may be wearing gloves) and when the knob is wet from rain or the fingers damp with perspiration.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a knob with a less rounded shape that provides greater leverage. Although the use of a front-panel control knob makes using the offset function very easy, it adds significantly to the crowding on the panel (see also Observation 4.06). If the function were transferred to the keyboard, the crowding on the right side of the panel would be eased.

2.10 **OBSERVATION:** In concept, the OFFSET procedure is made very simple by having the function relegated to a dedicated panel switch.

IMPACT: The presence of the OFFSET switch between the MODE and CHANNEL selectors tends to crowd the right-hand side of the panel. (See Observation 2.09.)

COMMENTS/POSSIBLE IMPROVEMENTS: If the procedure were controlled from the keyboard rather that by the present rotary control, there would be more room for the MODE and CHANNEL selectors, and the difficulties in operating the OFFSET switch (see Observation 2.09) would be eliminated. Controlling offsets from the keyboard would, however, add a certain amount of complexity to the operation of the radio. The trade off might be positive, however, since operator annoyance with the OFFSET switch was substantial.

2.11 **OBSERVATION:** One operator reported that the volume control (on the VAU-6088 unit) would not completely shut off the sound. This may be related to another operator comment that noted: "Beeping tone is still heard when volume control is turned off. Very dangerous in a tactical environment."

IMPACT: Possible breach of security.

COMMENTS/POSSIBLE IMPROVEMENTS: The operator should be able to shut off all sound completely without shutting off the radio. (Whether or not the whisper mode disenabled all tone and light indicators was undetermined.)

2.12 **OBSERVATION:** The mode switches on the ECCM unit (CPA-9088) and the Encryption/Decryption device (SEC-8088) are close to the screw posts.

IMPACT: Manipulation of the control knobs (especially into and out of the "SAVE" position, which requires the operator to pull and turn) is

hampered by the proximity of the posts. The problem would be exacerbated when the operator is wearing gloves.

COMMENTS/POSSIBLE IMPROVEMENTS: The knobs should be farther from the posts.

2.13 **OBSERVATION:** The erase buttons on the ECCM unit (CPA-9088) and the Encryption/Decryption device (SEC-8088) are recessed.

IMPACT: The ease with which these buttons can be activated with gloves or large fingers was undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the recess does not interfere with operation of the switches.

2.14 **OBSERVATION:** The keyboard and erase buttons have protective rubber caps, the durability of which was not assessed.

IMPACT: Despite the appearance of durability, one of the operators noted: "[I] don't think keypad can resist branches or something harder rubbing against [it]; think it might rip." Whether or not the push-buttons would withstand the constant application of pen-points, etc., was undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure the durability of the buttons.

2.15 **OBSERVATION:** The rubber covers on the keyboard keys deflect sideways when the buttons are pressed.

IMPACT: While the keys are well-spaced and easy to read, the tactile aspects of the keyboard are not distinct; the caps prohibit positive action of the keys and mask feedback from the "click" stops. One operator noted: "Sometimes it took a couple of times to finally get the number punched in."

COMMENTS/POSSIBLE IMPROVEMENTS: Redesign the physical characteristics of the keys.

Section 3: Display

3.01 **OBSERVATION:** The edges of the display can be read from a maximum of approximately 17 degrees above, 27 degrees below, 36 degrees to the left, and 43 degrees to the right.

IMPACT: It is impossible to read the edges of the display from operating positions outside the described perimeter. It is possible to misinterpret characters, especially when viewing from above and below.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase the smaller viewing angles. Ideally, the display would allow viewing from about 45 degrees in all directions.

3.02 **OBSERVATION:** The display allows six-characters: one "mode" letter and up to five digits. Each character is limited to seven segments. The display is therefore limited in the extent to which it can portray meaningful information to the operator, especially because of the seven-segment limitation.

IMPACT: The display is incapable of portraying appropriate characters for the letters a, B, D, e, f, g, G, j, k, K, m, M, n, N, p, q, Q, r, R, s, t, T, v, V, w, W, x, X, y, Y, z, and Z. Furthermore, 5 and S look the same, as do 6 and b, and 0 (zero) and O.

COMMENTS/POSSIBLE IMPROVEMENTS: A more versatile display could convey more complete and more meaningful information to operators (see Observations 3.07-3.11). Maximize the usefulness of the current display by providing more prompts and feedback. One method of compensating for the limitations of this kind of display is to provide alternating displays, so that a message can be lengthened by presenting two or more message components successively. (Avoid mixing numbers and letters that are represented by the same symbol in the same display message, such as 5's and S's. Avoid using similar or the same symbols to present different information.)

3.03 **OBSERVATION:** The display is small.

IMPACT: It may be difficult to read the display from some normal operating distances. One operator noted: "I can only read it from close distance."

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the display characters are large enough to be read easily from all normal operating positions.

3.04 **OBSERVATION:** The display window appears to be easily scratched.

IMPACT: The window may be prone to damage and degraded readability from physical abuse, especially in the backpack configuration.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the display window is strong and sufficiently resistant to scratching. Consider providing a protective shield.

3.05 **OBSERVATION:** The "NORM" position of the display light switch provides constant side lighting for the display.

IMPACT: The display may breach security if the operator forgets to turn it off or to use the four-second, momentary "ON" position of the switch.

COMMENTS/POSSIBLE IMPROVEMENTS: Consider eliminating the "NORM" feature and lengthening the momentary "ON" period with an option to turn the light off prior to the end of the time limit.

3.06 **OBSERVATION:** The display will accept the input of an invalid frequency and blink for four seconds before rejecting it and returning to the former valid frequency.

IMPACT: The operator may forget the meaning of the blinking display or not see it and therefore erroneously conclude that a new frequency has been entered. The purpose of the four-second delay is not understood.

COMMENTS/POSSIBLE IMPROVEMENTS: The display should be capable of simple alphabetical responses, such as "Error," which would disappear as soon as the operator responds. Failing that, the delay could be shortened so that the display essentially rejects invalid information immediately after a brief flashing and tone signal.

3.07 **OBSERVATION:** Battery condition, signal strength, and power output are indicated in the display by numbers ranging from 0 to 99. In the back-pack radio (PRC-80), for example, battery readings below 70 are considered too low, whereas power output is not considered low unless the number is below 30.

IMPACT: The scales are arbitrary and inconsistent with one another. Furthermore, ranging from 0 to 99, as they do, operators might inappropriately interpret them as percentages. The scales are not intuitively meaningful.

COMMENTS/POSSIBLE IMPROVEMENTS: Use scales that are more intuitively meaningful to operators. For example, instead of using 70 to 99 for battery condition, use 1 to 5, where the operator has been trained to interpret "b 1" as "low"; "b 2," "b 3," and "b 4" as medium; and "b 5" as good, or high. (See also Observation 3.08, Comment.)

3.08 **OBSERVATION:** The indication "d," displayed during the self-test and when checking the signal strength or output power, is not explained in the operator's manual.

IMPACT: The indication is not meaningful to the operator and does not distinguish among the different functions it represents.

COMMENTS/POSSIBLE IMPROVEMENTS: The limitations of the seven-segment display prohibit use of "T" or "t" (to indicate "Test"). Perhaps a series of "8's," indicating that all display character segments are working would be more appropriate than "d" during the self-test. (Fault indications would replace the 8's.) The signal strength could be indicated by "S S" followed by a number on a scale from 1 to 5 (this scale being typical in radio procedure). Power output would use the same numerical scale and "P O," or other appropriate abbreviation. (See also Observation 3.07, Comment.)

3.09 **OBSERVATION:** Positive self-test results are indicated only by an eight-second tone in the earphone. (See also Observation 6.05.)

IMPACT: There is no positive visual indication to the operator, who must listen for the tone.

COMMENTS/POSSIBLE IMPROVEMENTS: A display indication such as "PASS" might be helpful.

3.10 **OBSERVATION:** The mode letter "E" appears in the display when the "ECC" key is pressed. When "SEC" is pressed, however, the mode letter is not "S," as one might suppose, but rather "C."

IMPACT: The heuristic for choosing the mode letters is not self-consistent.

COMMENTS/POSSIBLE IMPROVEMENTS: Use "S" for "SEC" (even though "S" and "5" appear the same).

3.11 **OBSERVATION:** The mode letter "A" is displayed when the unassigned key "*" is pressed.

IMPACT: There is no logical correspondence between "A" and "*."

COMMENTS/POSSIBLE IMPROVEMENTS: The display is incapable of presenting the symbol "*"; therefore, it would probably be better if the display did not respond at all in this instance.

Section 4: Labels

4.01 **OBSERVATION:** The reference dots on the panel of the radio around some of the switch controls are inconsistently located with respect to their corresponding switch position labels. For example, on the CHANNEL selector, "6." is used for channel 6, while ".7" is used for channel 7.

IMPACT: Some of the dots appear to be out of place; others tend to resemble decimal points. Consequently, the labeling looks inconsistent, which increases the difficulty of discerning switch positions (especially when visual parallax is involved).

COMMENTS/POSSIBLE IMPROVEMENTS: To the extent possible, both the switch position label and its reference dot should be centered on the same radial vector.

4.02 **OBSERVATION:** As a multiple purpose switch, the label "POWER" is not entirely appropriate because it does not refer to the remote ("RMT") and no-transmit ("RCV") functions of the switch. (See also Observation 2.08.)

IMPACT: The use of controls with inadequate labeling is made more difficult for the untrained learner or for the naive operator who must try to operate the radio in an emergency.

COMMENTS/POSSIBLE IMPROVEMENTS: The switch should be relabeled with a more general term, or the functions unrelated to power should be moved elsewhere.

4.03 **OBSERVATION:** The label "RCV" on the so-called "POWER control" does not distinguish between the meanings "receive" and "receive only," of which the latter is intended. (See also Observation 2.08.)

IMPACT: The meaning of the label may be a little confusing to trainees or other naive operators, who may interpret it as implying that the radio will not receive unless the switch is in the "RCV" position.

COMMENTS/POSSIBLE IMPROVEMENTS: The label should connote "receive only"; perhaps the label "RCV ONLY" or the like would be appropriate. Of course, the amount of space for labeling around the "power" switch is limited; therefore, switch positions might have to be adjusted to accommodate the change, possibly as in the following illustration:

```
P ¦------------- PWR AMP
O ¦                 •
W ¦--- MED •                 • RMT
E ¦
R ¦-- LO •

    RCV ONLY •

             OFF •
```

4.04 **OBSERVATION:** On the channel selector the label "M" is partially obscured by the selector knob.

IMPACT: The difficulty of reading the selector position is increased. (See also Observation 4.01.)

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the "M" is placed outside the radius of the control knob.

4.05 **OBSERVATION:** The label "M" on the channel selector is a misnomer. This term implies that the so-called "manual" channel is, unlike the other channels, somehow nonautomatic (i.e., operated manually). This distinction appears to be superfluous, having no bearing on the operating features of any of the channels.

IMPACT: Although the term is widely used, both new and seasoned operators tend to be confused about the purpose, proper usage, and nature of so-called "manual" channels.

COMMENTS/POSSIBLE IMPROVEMENTS: Replace the term with an appropriate and informative designator that connotes the administrative (or other) nature of the channel.

4.06 **OBSERVATION:** The offset control obscures the labeling on the channel selector.

IMPACT: The labels "5" and "6" on the channel selector are totally obstructed from sight if viewed from more than approximately 25 degrees above them. (They are half obstructed at about 18 degrees.)

COMMENTS/POSSIBLE IMPROVEMENTS: See Observation 2.09, Comment.

4.07 **OBSERVATION:** The labels "FD" and "PR" on the 3 key are obscure. The manual does not specifically define them but rather forces the reader to deduce meanings as "signal strength" and "power output."

IMPACT: Trainees or operators who do not remember the alternate function of the 3 key will receive little or no help from the labels.

COMMENTS/POSSIBLE IMPROVEMENTS: Change the labels to something more intuitively informative.

4.08 **OBSERVATION:** The shift key is unlabeled.

IMPACT: The trainee and infrequent operator may forget the use of the key.

COMMENTS/POSSIBLE IMPROVEMENTS: Label the key, with the word "SHIFT," "ALT FCTN," an upward pointing arrow, or other appropriate designation.

4.09 **OBSERVATION:** The erase and save functions on the ECCM and communication security units are badly labeled. (See also Observation 1.05.)

IMPACT: The memory contents of the units can be accidentally lost. Operators are likely to be confused about the meaning and operational procedures associated with these labels.

COMMENTS/POSSIBLE IMPROVEMENTS: In order to erase the CPA-9088 memory, the MODE switch must be in the "SAVE" position, which is semantically incongruous with "erase." Moving the switch into the "SAVE" position will, apparently, erase the memory contents rather than "save" them (see Observation 1.05, Comment; "SAVE" would appear to refer to the battery rather than the memory.) Because of the potential importance of the emergency erase function, this matter needs to be clarified. The label "SAVE" might better be something like "STOW," as in the following configuration (where the boxed labels indicated a pull-to-engage detent):

```
              |-- ECC --|
              |         |
          OFF •         • ON
                              -------
      LOAD •             • |_ERASE_|
                              |
     ------                   |
     |_STOW_| •               |
                              v

                             PUSH
```

4.10 **OBSERVATION:** On the top of the ECCM unit is found the following message for the operator: "CAUTION: Pull the MODE switch before setting to save position." However, because the switch cannot be moved to "SAVE" without pulling it, the word "caution" is misleading: It implies that the switch can, but should not, be moved to "SAVE" without pulling to engage.

IMPACT: Semantic confusion.

COMMENTS/POSSIBLE IMPROVEMENTS: The word "caution" should be "NOTE" or some other appropriate term.

Section 5: Connectors and Cables

5.01 **OBSERVATION:** The protective metal cap on the IF OUT receptacle is small, crowded, and requires significant force to remove.

IMPACT: The cap is difficult to connect and disconnect.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide cap that is easier to grasp and manipulate.

5.02 **OBSERVATION:** The rubber cap and attachment cord on the antenna receptacle interfere with viewing the light switch.

IMPACT: An inconvenience.

COMMENTS/POSSIBLE IMPROVEMENTS: Although the impact of this particular instance would be minor in most instances, the general problem of obstructed view should be considered and avoided to the extent possible in the design of panel components.

5.03 **OBSERVATION:** The retaining cords on the rubber connector caps tend to get tangled.

IMPACT: The cords can obstruct operational and maintenance procedures.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide caps that are integral to the connectors and whose attachments are strong but do not interfere with procedures.

5.04 **OBSERVATION:** The rubber connector caps are not well connected to their retaining cords.

IMPACT: The caps can be lost easily.

COMMENTS/POSSIBLE IMPROVEMENTS: See Observation 5.03, Comment.

5.05 **OBSERVATION:** The rubber caps on the antenna, remote, and audio connectors are removed by lifting on a tab. Will the tabs tend to break off with extended use? The likelihood of this occurrence was undetermined.

IMPACT: Some caps might be difficult to remove without tabs (but see Observation 5.06).

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the likelihood of occurrence is small. (See Observation 5.06, Comment.)

5.06 **OBSERVATION:** The rubber cap on the audio unit (AU-4088) comes off too easily.

IMPACT: The connectors could be subjected to moisture or debris if the caps came off accidentally.

COMMENTS/POSSIBLE IMPROVEMENTS: Caps should be easily removable, so that removal can be accomplished quickly under adverse conditions (wet, cold, etc.), but the design should not be conducive to accidental removal.

5.07 **OBSERVATION:** The power amplifier connector at the rear of the vehicular audio unit (VAU-6088) has a rubber protective cap that dangles freely on a retaining cord.

IMPACT: The cap tends to get caught between the radio and the rear rail of the mounting unit (MT-7088), bottom shelf, during installation.

COMMENTS/POSSIBLE IMPROVEMENTS: See Observation 5.03, Comment.

5.08 **OBSERVATION:** One operator noted that some of the connector plugs were difficult to install and remove. The design of certain plugs and sockets sometimes makes it physically difficult for operators to make connections quickly and easily, especially under adverse conditions (such as darkness, cold temperatures, wearing gloves, wearing NBC gear, etc.)

IMPACT: The impact could vary from a mere annoyance to a serious problem, depending on circumstances.

COMMENTS/POSSIBLE IMPROVEMENTS: Use only connectors that can be shown to be easily and reliably used under a variety of adverse circumstances.

5.09 **OBSERVATION:** The rear retaining screws for the add-on units were not captive. (One and one-half turns of the connecting screws was sufficient to connect the modules.) Access to interiors of components is accomplished by removing Phillips head screws that are also not captive.

IMPACT: Any of the screws, when removed, would, of course, be prone to loss. Whether the screws for the add-on units would work themselves loose and components come apart is unknown.

COMMENTS/POSSIBLE IMPROVEMENTS: All screws should be captive to guard against loss. Consider an alternative method of fastening the add-on units together--clamps, for example, as used on the battery box (but see Observation 5.12, Impact).

5.10 **OBSERVATION:** One operator suggested that the screws used to attach the add-on modules might become severely worn in time. The likelihood of this was not assessed. (See also Observation 6.02.)

IMPACT: If the problem occurred, it might become difficult to attach modules properly.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the problem is unlikely to occur.

5.11 **OBSERVATION:** The latches for securing the battery box (CY-2088) to the audio unit (AU-4088) extend beyond the plane of the top panel of the radio.

IMPACT: The audio unit (and radio, if attached) will not lie flat. The latches are exposed to abuse from impact and may cause damage to other surfaces.

COMMENTS/POSSIBLE IMPROVEMENTS: An attempt should be made to design controls, latches, etc. so that they do not extend beyond the main surfaces (or protective rails, posts, etc.) of the equipment.

5.12 **OBSERVATION:** The finger hooks on the battery box (CY-2088) latches are curved in toward the radio casing to prevent them from catching on foreign objects.

IMPACT: The hooks are so close to the radio casing that the finger tips cannot be slipped under them to spring open the latch. As one operator reported, the "clamps are hard to use." Another said: "Battery box hard to open."

COMMENTS/POSSIBLE IMPROVEMENTS: Ample space for fingers (and gloves) should be allow.

5.13 **OBSERVATION:** The battery connectors on the battery box (CY-2088) are exposed to physical damage when the box is not attached to the audio unit (AU-4088).

IMPACT: The radio could be rendered inoperable if damaged connectors would not allow proper battery installation.

COMMENTS/POSSIBLE IMPROVEMENTS: Connectors should be recessed or otherwise protected (by posts, rails, etc.).

Section 6: Operational Procedures

6.01 **OBSERVATION:** Operators offered several critical comments about installing the radio in the vehicular mount: (a) "The mount has to be redesigned . . . [the] radio does not slide into mount easily"; (b) "Radio is very awkward to put in mount"; (c) "Mounting the [radio] is very difficult . . ."; (d) "Mounting the Tadiran radio is difficult. It does not seat properly into the mount. With the amp [already] mounted on top . . . , it is difficult seating [the radio]. You have to put the radio in first, then reach through the top where the amp is and pull the radio up to seat [it] properly"; (e) "Difficult to install radio in mount because receptacles do not line up as they should. Equipment needs a groove to insure proper installation"; (f) "Mounting of this radio sometimes is a task within itself. I think the mounting procedures could be a little easier and . . . faster."

IMPACT: Obviously, operators were frustrated by a process that they felt was time-consuming and inefficient.

COMMENTS/POSSIBLE IMPROVEMENTS: It goes without saying, the mounting and dismounting of vehicular equipment should be able to be accomplished quickly and easily; however, a solution to the particular installation problems incurred during the assessment was not sought.

6.02 **OBSERVATION:** Installation of the three add-on units (audio, ECCM, and encryption) requires a tool such as a coin or screwdriver. Each unit requires two screws. (See also Observation 5.10.)

IMPACT: The assembly of parts is time consuming and awkward and would be further hindered if a tool were not immediately available.

COMMENTS/POSSIBLE IMPROVEMENTS: Tools should not be required for any operator assembled components.

6.03 **OBSERVATION:** Start-up procedures call for rotating the VOL (volume) control midway, but there is no midway mark on the volume scale.

IMPACT: Minor inconvenience.

COMMENTS/POSSIBLE IMPROVEMENTS: As a general rule, if standard procedures call for a particular operation, there should be an appropriate means to accomplish the operation effectively and efficiently. To the crescent scale could be added several discrete marks, one indicating midrange.

6.04 **OBSERVATION:** The last digit of the frequency must be entered manually.

IMPACT: A small amount of time is wasted on a procedure that could be automatic, since the last digit is always determined by the next to the last.

COMMENTS/POSSIBLE IMPROVEMENTS: A zero or a five in the fourth position should automatically produce a zero in the last position. A two or a seven in the fourth position should automatically produce a five in the last position.

6.05 **OBSERVATION:** One operator remarked that the continuous tone that occurs during the self-test function is "not needed and annoying" and that "it would be [better] to use a blinking . . . light." (See also Observation 3.09.)

IMPACT: The long duration of the tone may be annoying to operators. Also, it may be heard from a distance if precautions are not taken.

COMMENTS/POSSIBLE IMPROVEMENTS: The long duration may be unnecessary; certainly it need not be so long to be informative. The information it signifies could probably be more effectively conveyed by the display.

6.06 **OBSERVATION:** One operator remarked that operating the radio involved "too many procedures for a field-fire environment."

IMPACT: Although the impact of the operational complexity of this radio on performance in realistic battle-like conditions was not assessed, the operator makes a point worthy of repeated emphasis: In general, operational complexity can significantly detract from the operator's ability to accomplish the mission under adverse conditions. What may ordinarily be a routine task may become quite difficult or impossible to accomplish in the midst of the battlefield.

COMMENTS/POSSIBLE IMPROVEMENTS: It behooves system developers to minimize task complexity to the maximum extent feasible.

Section 7: Miscellaneous

7.01 **OBSERVATION:** The radio utilizes four separate, non-integrated, modular, add-on units: an audio unit for the backpack configuration, a different audio unit for vehicular installations, an ECCM unit, and an encryption unit.

IMPACT: The modular aspect of the equipment has certain inherent disadvantages, especially in the areas of handling, weight, and size. Installation procedures are made more complicated and time consuming by the necessity of combining the radio with add-on ECCM, security, and audio modules. The final product is relatively large and heavy. The requirement to handle, ship, store, and account for separate parts presents additional logistical problems.

COMMENTS/POSSIBLE IMPROVEMENTS: In general, the theory behind the modular components is unclear to us. What are the advantages? Would it not be more effective to package most components in one housing, as most other radios in this class do? Also, the requirement for two different audio units, one for the backpack and one for vehicles, is not understood. With appropriate design modifications, would it be possible to use the backpack unit AU-4088 (without the battery box CY-2088) for the vehicular installation as well? Whether the cost advantage, security advantage, and other advantages of being able to eliminate unneeded components for certain military scenarios or applications outweighs the expense of having a single, integrated unit is not known.

7.02 **OBSERVATION:** The backpack radio with add-on ECCM and encryption units becomes very wide and heavy.

IMPACT: The radio is approximately 13.5 inches wide with one add-on unit and approximately 17.0 inches wide with two add-on units. The radio with add-ons constitutes a significant burden in the backpack configuration, especially when considered along with other equipment the soldier must carry. Vehicular installation might have to be modified in some instances to accommodate add-on units.

COMMENTS/POSSIBLE IMPROVEMENTS: Every effort should be exerted to make soldier-portable radios as small and light as possible. (Ref. MIL-STD-1472C, para. 5.11.1.)

7.03 **OBSERVATION:** The radio does not have effective carry handles.

IMPACT: The radio is difficult to transport by hand. Furthermore, although the radio can be secured against theft by chain or cable (attached to the rails on the left side of the radio and on the right side of the audio unit), unless both sides are tightly secured to each other as well as to the vehicle, it would be possible to remove a center add-on unit by removing the screws that retain it.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide an adequate carry facility for operators and maintenance personnel, and devise some simple means of locking the component units together and to the vehicle.

7.04 **OBSERVATION:** One operator suggested that the radio needs a built-in speaker.

IMPACT: The operator said: "If your hand mic goes out and your external communication is down, this is a serious problem."

COMMENTS/POSSIBLE IMPROVEMENTS: It is assumed that the pros and cons of internal speakers and microphones have been discussed at length elsewhere. One thing that may not have been considered is the unreliability of handsets (and their connectors and cords) because of their susceptibility to damage. The handset may be the "weak link in the chain," for which alternate (internal) speakers and microphones would compensate, especially in backpack configurations.

7.05 **OBSERVATION:** The SYNC indicator light on the ECCM unit is highly reflective.

IMPACT: The reflective properties of the indicator make it appear to be "on" much of the time. This indicator was much more reflective than five similar fault indicator lights (on the radio, the ECCM unit, the two backpack and vehicular audio units, and the encryption unit).

COMMENTS/POSSIBLE IMPROVEMENTS: A related comment by one operator indicated that all the lamps may also appear to be "on" when struck by sunlight. Regardless, the lamps should appear dark and identical when not activated.

7.06 **OBSERVATION:** The upper mast section (AT-2808) of the long whip antenna (AT-288) examined would not assemble properly because the retention cylinder at the top of the second element had broken loose from the mast tubing and was sliding free.

IMPACT: Possible unavailability and unreliability of equipment.

COMMENTS/POSSIBLE IMPROVEMENTS: Whether this problem was an isolated occurrence or a symptom of an underlying quality control problem with the welds is unknown. It should be pursued to ensure that it is not the latter.

7.07 **OBSERVATION:** The antenna support base (AB-388) for the long whip antenna (AT-288) is slightly flexible if great force is applied, but it springs back to a straight position when the force is removed.

IMPACT: If the operator wishes the antenna to be in an upright position, the radio must also be upright. If the operator is in a prone position while carrying the backpack radio, the antenna cannot be upright.

COMMENTS/POSSIBLE IMPROVEMENTS: A flexible base would allow greater freedom for antenna orientation.

7.08 **OBSERVATION:** The long (11-1/4 inches) antenna support base (AB-388), while very sturdy and easy to use, is very heavy.

IMPACT: The weight of the antenna base adds significantly to the soldier's burden.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a light-weight antenna base.

7.09 **OBSERVATION:** Two operator comments complained about the design of the backpack harness. One of them stated: "The manpack is built completely wrong. Needs waist belt. Arm straps are not to hold pack up."

IMPACT: The effectiveness of the harness was not formally evaluated. Apparently some operators felt that weight distribution was not optimal.

COMMENTS/POSSIBLE IMPROVEMENTS: Because of the extra weight associated with the add-on units, it is especially important to ensure that the backpack harness is designed ergonomically. (Ref. MIL-STD-1472C, para. 5.11.1.)

7.10 **OBSERVATION:** The handset (H-189) pressel is on the side of the handset.

IMPACT: The switch is vulnerable to impact, wear (etc.) in addition to being more difficult for left-handed operators to use.

COMMENTS/POSSIBLE IMPROVEMENTS: Put the switch on the inside of the handle.

7.11 **OBSERVATION:** The clip on the handset is small.

IMPACT: It may be difficult for operators to use the clip effectively.

COMMENTS/POSSIBLE IMPROVEMENTS: Enlarge the clip.

7.12 **OBSERVATION:** One operator said: "[I] cannot hear hailing while engine is running."

IMPACT: The extent of this problem was not determined, but ambient noise could produce a significant degradation in communications.

COMMENTS/POSSIBLE IMPROVEMENTS: The radio operator should always be able to hear or "see" incoming communications during normal operational conditions.

THOMSON: DETAILED OBSERVATIONS

Two Thomson radios were evaluated: the fixed-frequency "Man-Pack" (TRC 577) and the vehicular frequency-hopping radio (TRC 950). The following observations derive from two sources: (a) written comments of the 12 soldiers trained to operate the Thomson radios, and (b) the findings of two human factors specialists who independently assessed the operator-radio interface characteristics of the radios. The "comments" and "possible improvements" are offered as suggestions only. They are not necessarily exhaustive, sufficient, consistent with one another, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine.

Section 1: Operator's Manuals

1.01 **OBSERVATION:** Three Thompson manuals were evaluated: the "TRC 950 Data Preparation Manual" (MAP 186GB/88045105/ISSUE:2-8603), the "TRC 950 Operating Instructions" (MAE 186GB/88045022/ISSUE:2-8603), and the "TRC 577 Operating Instructions" (MAE 190GB/88044471/ISSUE: 1-8408). Because the data preparation manual is used in conjunction with the other two and the three manuals were similar in format and presentation, the results represent a compilation of the assessments of all three documents (see Observation 1.02). On a scale ranging from -100 (poor) to +100 (good), the Thomson manuals were given the following scores by the reviewers (two human factors specialists): Content (+29); Readability (+71); Illustration (+75); Durability (-50). An overall mean of +35 was obtained by weighting the four content areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean indicated that the manuals were considered adequate in most respects. Areas receiving negative evaluations were the following: subject index, safety hazards, reading level, and durability.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

1.02 **OBSERVATION:** Operating instructions are divided among three different manuals (see Observation 1.01).

IMPACT: The requirement to use three documents, each of which contains material that is redundant is inefficient both logistically and for training and reference purposes.

COMMENTS/POSSIBLE IMPROVEMENTS: Incorporate the three manuals into one.

1.03 **OBSERVATION:** The manuals have no indexes.

IMPACT: It is difficult for the operator to locate specific information quickly. One operator noted: "I had to flip through pages in order to find what I wanted. The table of contents was too general."

COMMENTS/POSSIBLE IMPROVEMENTS: Although the manuals have tables of contents that are rather detailed, they would be improved significantly with the addition of complete indexes so that operators could locate information by keywords rather than by general topic.

1.04 **OBSERVATION:** Several operators indicated that the manuals were too complex or otherwise inadequate: (a) "Need better manuals"; (b) "I'm glad there was someone to explain what the manual was saying --[it] was okay [as] reference material after I new what I was doing"; (c) "[The manual] was too far advanced for only [a] five-day course"; (d) "[There were] too [many] unimportant things--not enough simple explanations of operations."

IMPACT: The usefulness of the manuals as training aids is limited by the complexity of the presentation. Soldiers must rely more heavily on other sources of information (instructors, etc.).

COMMENTS/POSSIBLE IMPROVEMENTS: Manuals for operators should contain primarily material that is required or useful for operation and maintenance of the equipment. The presentation should be simple and to the point. Unnecessary elaborations should be forgone.

1.05 **OBSERVATION:** The text and illustrations in the manuals refer to controls and features of the radio by number rather than by name. (See also Observation 4.01.)

IMPACT: The number conveys no semantic meaning to the operator or trainee except by reference to a picture or coded list of names. Hence, the operator or trainee is constantly forced to refer to the reference lists in order to understand the text. This is a frustrating waste of time and is an inefficient method of teaching operational and maintenance procedures. It also detracts from the usefulness of the manuals as reference documents for the trained operator.

COMMENTS/POSSIBLE IMPROVEMENTS: The manuals should teach operators to refer to parts of the radio by name rather than by number. For example, in the statement "When pressing push-button #4 (after a signal has been heard), one of the following indications can be displayed," the words "push-button #4" should be replaced by "the display-light button." Use appropriate names in the text and ensure that accompanying illustrations are labeled effectively for quick reference.

1.06 **OBSERVATION:** Apparently, the manuals have been translated from French into English. The quality of the translation, while forgivable, under the circumstances, is inadequate.

IMPACT: The awkward English would present a definite stumbling block to the U.S. operator/trainee.

COMMENTS/POSSIBLE IMPROVEMENTS: The manual needs to be rewritten in language that is idiomatic and familiar to the U.S. soldier.

1.07 **OBSERVATION:** The frequency-hopping radio (TRC 950) operating instructions manual has a series of appendices that are neither listed in the table of contents nor page numbered.

IMPACT: The appendices are difficult to use.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

1.08 **OBSERVATION:** The "Man-pack" (TRC 577) manual does not make it clear whether the "SEC" connector (#11) and the #12 connector (unlabeled in the manual) can be used interchangeably. The handset and speaker plugs fit on either connector. (See also Observation 4.03.)

IMPACT: The operator or trainee may be confused.

COMMENTS/POSSIBLE IMPROVEMENTS: Clearly specify the capabilities of each connector.

1.09 **OBSERVATION:** Both TRC 950 manuals have a three-page foldout incorporated into the back cover.

IMPACT: The foldouts are too large, which makes them cumbersome to use for training purposes and extremely awkward (but necessary) for casual reference.

COMMENTS/POSSIBLE IMPROVEMENTS: Reduce the size of the illustrations and accompanying information to allow the material to fit on two pages. The operator would then have to fold out only two pages instead of three, and the manual would be much less unwieldy. Consider, also, starting the foldout on the inside of the back cover (which would sacrifice the ability to view the whole illustration with the manual opened to another part, but would be much handier for the periodic referencing expected of the experienced operator and would necessitate folding out only one page.)

1.10 **OBSERVATION:** The material on each page of each manual is enclosed in a box.

IMPACT: The boxes are sometimes a confusing addition to the text, inasmuch as they detract from the ease of finding the beginnings and endings of various sections: The top of each page looks like (but may not be) the beginning of a section; the bottom of each page looks like (but may not be) the end of a section.

COMMENTS/POSSIBLE IMPROVEMENTS: Eliminate the boxes.

Section 2: Operating Controls

2.01 **OBSERVATION:** The front panel controls on the TRC 950 (vehicular, frequency-hopping) and TRC 577 (backpack) radios are not illuminated for use in low-light or no-light situations.

IMPACT: Operators view this as a significant problem, especially for the backpack radio, which has no lighted display. One operator commented: "Many times, at night, I had to use memory, touch, or trial-and-error methods in order to operate effectively." The lack of panel lighting makes it difficult or impossible for operators to manipulate the controls effectively in the dark without some sort of external light source, such as a flashlight, which may breach security.

COMMENTS/POSSIBLE IMPROVEMENTS: Consider providing back-lighting or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

2.02 **OBSERVATION:** The control knobs on both the frequency-hopping and backpack radios are symmetrical.

IMPACT: Although the knobs are coded to indicate the pointing direction, the shape alone does not provide unambiguous indication of switch settings, especially in low-light or dark or from side angles of view.

COMMENTS/POSSIBLE IMPROVEMENTS: Use knobs with shapes that point, irrespective of any reference markings they may possess. The shape should minimize parallax distortion (normally achieved by sloping the pointer toward reference marks on the face of the panel). Conform to the design specifications presented in MIL-STD-1472C.

2.03 **OBSERVATION:** The control knobs on both the frequency-hopping and backpack radios have rather sharp edges and corners.

IMPACT: Occasionally the edges and corners of adjacent controls inflict pain on the operator's knuckles. The problem is worse in the backpack version because of the generally closer proximity of the controls (see Observation 2.14).

COMMENTS/POSSIBLE IMPROVEMENTS: The edges and corners of the control knobs should be more rounded.

2.04 **OBSERVATION:** On the frequency-hopping radio, the control panel knobs are spaced adequately (but see Observations 5.05-5.07) except for the function/self-test switch, which is crowded by the cover on the keyboard and the retaining strap on the cap over the erase (zeroize) button (see Observation 2.05). Also, an operator stated the following possible exception: "The keypad [door] knob is too close to the channel knob."

IMPACT: The function/self-test switch is awkward to manipulate within the confined space. (Also, the knob on the keyboard door may interfere with the operation of the network selector switch.)

COMMENTS/POSSIBLE IMPROVEMENTS: The data-storage battery access plug and the two fuse holders occupy a significant amount of front panel space. Perhaps some rearrangement involving these features would yield more space for the function/self-test switch. Alternatively, modification of the method of containing the erase button cap could help (see Observation 2.05). (As for the keyboard cover knob, perhaps it could be raised, or replace by an alternative latch mechanism [but see Observation 2.13].)

2.05 **OBSERVATION:** The cap on the emergency-erase button of the frequency-hopping radio has a retaining strap that protrudes downward toward the function/self-test switch. (See also Observation 2.06).

IMPACT: The strap obstructs the manipulation of the function/self-test switch and is a source of annoyance to the operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Redesign the method of containing the cap, or reorient the strap. (This action would be obviated by the implementation of the suggestion in the comment for Observation 2.06.)

2.06 **OBSERVATION:** The emergency-erase control on the frequency-hopping radio is a push-button.

IMPACT: With its protective cap in place, accidental pressing of the button would probably be rare. Nevertheless, caps are frequently missing, lost, or not utilized religiously, which increases the probability of accidental erasures.

COMMENTS/POSSIBLE IMPROVEMENTS: A better control device for emergency erasures would be a rotary knob that requires pulling or depressing before it can be turned to the erase position.

2.07 **OBSERVATION:** The function/self-test switch on the frequency-hopping radio has no interlock between the "master" position and the "direct initial data entry" position.

IMPACT: The operator is not prevented from accidentally setting the switch to the data-entry position during normal operations (which would inhibit transmissions and receptions).

COMMENTS/POSSIBLE IMPROVEMENTS: A pull-to-engage interlock on the data-entry position would remind the operator that this position must be used for data entry only.

2.08 **OBSERVATION:** The so-called "audio volume switch" (see Observation 2.09) on the frequency-hopping radio has no interlock between the volume function and the other functions of the switch.

IMPACT: The switch can be inadvertently turned out of the volume range while adjusting volume--producing an unintended loss of rescue-frequency monitoring.

COMMENTS/POSSIBLE IMPROVEMENTS: Because the appropriate control of volume level many require frequent adjustment of this switch, it would be convenient to have an interlock that prevents the switch from being inadvertently turned out of the volume range.

2.09 **OBSERVATION:** On the frequency-hopping radio, the volume control is incorporated into the same switch that controls data transmissions and the monitoring of the rescue frequency.

IMPACT: The control of volume is lost when the switch is set on "inhibit rescue frequency monitoring" or the "data" position. One operator offered the following comment: "You can't control volume when using the data mode. It would have been much more convenient to be able to turn up the radio [volume] when weak transmissions were coming in, than sticking the handset half in my ear!"

COMMENTS/POSSIBLE IMPROVEMENTS: In general, unless it is desirable for certain functions to be mutually inhibiting, it is usually better to provide separate switches for their control.

2.10 **OBSERVATION:** The so-called "squelch level switch" (see Observations 4.10 & 4.11) on the frequency-hopping radio has no interlock between the relay and non-relay positions.

IMPACT: The switch can be inadvertently moved out of the non-relay positions, with a consequential loss in the ability to monitor rescue frequencies.

COMMENTS/POSSIBLE IMPROVEMENTS: Because the usual setting of this switch would normally be on one of the non-relay positions, an interlock between the relay and non-relay setting would help to distinguish the functions and prevent inadvertent movement of the switch into undesired positions.

2.11 **OBSERVATION:** The keypad on the frequency-hopping radio does not have a positive feel. Although the keys have "click stops," they vary slightly in quality (resistance) from key to key. The keys also have a "spongy" feeling and are easily deflected to the side when pressed, which contributes to the lack of positive feel. The operation of the keys was the subject of much operator criticism: For example, (a) "Frequency-setting push-buttons could be easier; [it] would be nice to have them more like 'soft-touch' control buttons"; (b) "The buttons on the keyboard need to [function more easily]"; (c) "[Need] better feel of keypads when touched."

IMPACT: The keys do not always register when pressed; when they do register, the operator receives inadequate tactile feedback. Examples

of operator comments: (a) "[The keys] require a lot of pressure to enter what you wish, which causes your finger to get sore after continually pushing them"; (b) "Sometimes a certain key won't work"; (c) "Keypad buttons didn't always register when pushed; maybe a 'soft-touch' type button system would be better"; (d) "Keys will not be able to be pressed when you are wearing cold weather gloves or mittens"; (e) "I don't think you can operate [the] keyboard with mittens on because they would be too close together for your fingers to press only one button at a time. Also, after a period of time your finger becomes tired; the keys seem a little [hard to press]."

2.12 **OBSERVATION:** The durability of the keyboard push-buttons on the frequency-hopping radio was undetermined, but is questionable. One operator noted: "I don't believe the buttons will last long in a combat unit. GI's have tendencies to use things such as pens [and] pencils [for pressing the buttons]."

IMPACT: Because of problems like those cited in Observation 2.11, soldiers may have a greater tendency to press the keys with sharp objects. To what extent the rubber-like surface of the keys would withstand that kind of treatment is unknown.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the physical characteristics of the push-button keys will enable them to withstand considerable punishment of the type described.

2.13 **OBSERVATION:** The purpose of the protective door over the keyboard on the frequency-hopping radio is unclear.

IMPACT: When open, the door is subject to damage and reduces the accessibility of the emergency erase push-button, the function and self-test switch, and the coaxial antenna receptacle. Opening and closing the door constitutes an additional operational step. (See also Observation 3.01, Comment.)

COMMENTS/POSSIBLE IMPROVEMENTS: Unless necessary or desirable for reasons that were not apparent to the evaluators, the door should be eliminated.

2.14 **OBSERVATION:** The knobs on the backpack radio are spaced too close together; they are separated by approximately 5/8 inch. (See also Observation 2.15.)

IMPACT: (See impact statement for Observation 2.03.) Because of the proximity of the controls, they are accessible to finger-tip control only. One operator offered the following comment: "I feel [that] just a little more space . . . would be necessary for an individual to operate the control knobs easily in a cold weather environment." The comment points to the fact that the necessity to use cold weather gloves would probably exacerbate this problem significantly.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, controls such as those on the backpack radio should be spaced about one inch apart. Unfortunately, there is not enough room on the backpack radio control panel for that much separation. Nevertheless, the separation should be maximized to the extent possible.

2.15 **OBSERVATION:** The four rotary switches used for control of frequencies on the backpack radio occupy approximately 25% of the front panel space.

IMPACT: The number of frequency controls necessitates their being placed too close together. (See impact statement for Observation 2.14.)

COMMENTS/POSSIBLE IMPROVEMENTS: An inordinate amount of panel space is devoted to what is essentially a single function. The use of thumbwheel controls might alleviate the space problem (ref. MIL-STD-1472C, par. 5.4.2.1.3).

2.16 **OBSERVATION:** On the backpack radio examined, the leftmost frequency selector switch was significantly more difficult to turn than the other three. Whether the anomaly was present in all the backpack radios was not determined.

IMPACT: Inconsistency among similar controls. Operator annoyance.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that this problem does not represent a manufacturing reliability problem or design error.

2.17 **OBSERVATION:** On the backpack radio, the ON/OFF transmission power switch and the squelch control are located directly above the two connectors for audio and accessory equipment.

IMPACT: The accessibility of the controls may be restricted in some situations by the connectors and cables installed on the receptacles.

COMMENTS/POSSIBLE IMPROVEMENTS: Interchange the positions of the "connector receptacle for complementary accessory or equipment" (switch #11) and the squelch control. (See also Observation 2.18.)

2.18 **OBSERVATION:** On the backpack radio, the ground terminal and squelch control are located too close to each other.

IMPACT: The ground terminal interferes slightly with moving the squelch control.

COMMENTS/POSSIBLE IMPROVEMENTS: Same as for Observation 2.17.

2.19 **OBSERVATION:** Two operator comments indicated concern over the ruggedness of the control knobs of the radios. In addition, the toggle switch for controlling antenna selection on the backpack radio gives the appearance of being of light-duty construction.

IMPACT: One operator noted: "[The] radio needs some sort of protection guards to keep knobs from being broken off." Another commented: "I was not very impressed with the control knobs. The material they were made of won't last 6 months . . . in a combat unit [that] goes to the field often." This problem would, of course, be more serious in connection with the backpack radio (TRC 577).

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that all controls and switches are designed to withstand the normal rigors of the battlefield and training exercises.

2.20 **OBSERVATION:** The radios have no signal strength meters.

IMPACT: The operator cannot determine the accuracy of the power output during transmission, determine what the incoming signal strength is during communication, or detect the presence of other RF energy.

COMMENTS/POSSIBLE IMPROVEMENTS: Consider the advisability of providing a signal strength meter.

2.21 **OBSERVATION:** The radios have no power-on lamp.

IMPACT: The is no visual confirmation that power is present in the unit.

COMMENTS/POSSIBLE IMPROVEMENTS: A power-on lamp would be useful in trouble-shooting and as a reminder to turn off the power at appropriate times.

2.22 Several operator comments complained that the pressel on the handset required too much force to activate and maintain. The handset in question was probably the COT 205-10, the COT 206-10, or both (see Observation 9.04).

IMPACT: During frequent or prolonged transmissions the operator's hand may become fatigued.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the force required to activate the pressel is appropriate for "heavy-traffic" situations.

2.23 **OBSERVATION:** One operator made the following comment pertaining to the handset: "When handset was keyed, transceiver stuck in the transmit mode. Power had to be turned off, then on, to get the transceiver out of the transmit mode. This happened for about 15 minutes." The cause of the problem was not indicated.

IMPACT: Wasted time. Lost communications.

COMMENTS/POSSIBLE IMPROVEMENTS: It is not known whether the problem was an unlikely occurrence or not, or to what extent the problem indicates a more general reliability problem with the handset.

2.24 **OBSERVATION:** The four-position channel switch on the handset--the operation of which was not explained by the operator's manual--is not easily accessible.

IMPACT: The operator may have difficulty using the switch, especially while wearing gloves.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the switch is easily accessible under all anticipated operational conditions.

2.25 **OBSERVATION:** The adjusting ring on the directional microphone of the handset was very difficult (sometimes impossible) to rotate and appeared to be rather fragile and likely to collect debris.

IMPACT: The feature was impossible to use effectively on the handset examined. The mechanism may break if abused or collect debris--as may be likely in the backpack configuration of the radio.

Section 3: Display

3.01 **OBSERVATION:** The edges of the frequency-hopping radio display can be read from a maximum of approximately 40 degrees above, 40 degrees below, 31 degrees to the left, and 44 degrees to the right.

IMPACT: It is impossible to read the edges of the display from operating positions outside the described perimeter. It is possible to misinterpret characters, especially at the ends of the display.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, the display would allow viewing from about 45 degrees in all directions, although the present values are probably acceptable. Removing the keyboard protective cover (see Observation 2.13) would enhance readability from the left.

3.02 **OBSERVATION:** Operators were concerned that the display window on the frequency-hopping radio is rather vulnerable to scratching and impact.

IMPACT: Degraded readability.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the display window is strong and sufficiently resistant to scratching. Consider providing a protective shield or guard rails.

3.03 **OBSERVATION:** The display on the frequency-hopping radio is a red LED.

IMPACT: When a red ambient light is used during light-discipline situations, the visibility of the display may be degraded significantly. Also, as one operator noted: "If you are operating . . . this radio in any kind of sunlight, the data on the screen is extremely hard to read."

COMMENTS/POSSIBLE IMPROVEMENTS: Consider changing the LED to blue-green.

3.04 **OBSERVATION:** The brightness of the display on the frequency-hopping radio is not variable.

IMPACT: The display may be too bright during nighttime operations and thus breach security.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a dim control.

3.05 **OBSERVATION:** The frequency-hopping radio display makes much use of the question mark ("?"), but the character is presented without the dot underneath the swirl.

IMPACT: For trainees or others who are relatively unfamiliar with the display, the question mark can be mistaken as the number "7."

COMMENTS/POSSIBLE IMPROVEMENTS: Add the dot to the question mark. (But see Observation 3.06.)

3.06 **OBSERVATION:** A question mark ("?") is used in the frequency-hopping display to indicate fault conditions, the absence of information, and pending operations.

IMPACT: The question mark is inappropriate for uses other than queries. The current multiple usage is confusing.

COMMENTS/POSSIBLE IMPROVEMENTS: Use other indications as appropriate--such as: "FAIL," "ERR," "BATT," "NO FREQ" (or "NO FQ," or "NO F"), "NO FX FQ" (or "NO FF"), "NO CIPH," "NO ECC," "NO ECC-C," "NO DATA," "NO SYNC," "RCV ONLY," "NO REM," "FUSE," etc.

3.07 **OBSERVATION:** The edges of the backpack-radio frequency-displays can be read from a maximum of approximately 37 degrees above, 8 to 16 degrees below (depending on the position of the frequency selector switches), 40 to 50 degrees to the left (depending on how well the numbers are centered in the display windows), and 40 to 50 degrees to the right (depending on how well the numbers are centered in the display windows).

IMPACT: It is impossible to read the edges of the display from operating positions outside the described perimeter. While satisfactory from the top, the left, and the right, the accessibility to viewing from low angles is very restricted--although the impact of this shortcoming would not seem especially serious in the backpack configuration, because viewing the radio from below would probably be infrequent.

COMMENTS/POSSIBLE IMPROVEMENTS: Ideally, the displays would allow viewing from about 45 degrees in all directions.

3.08 **OBSERVATION:** On the backpack radio examined, the frequency number appearing in the leftmost display window was off center.

IMPACT: Accessibility to viewing from a side angle was restricted.

COMMENTS/POSSIBLE IMPROVEMENTS: Design and assembly procedures should ensure that all numerals are exactly centered in their respective display windows.

3.09 **OBSERVATION:** The frequency-display windows on the backpack radio are prone to collecting debris.

IMPACT: Obscuration of the display. At least one of the operators experienced the problem: "Dirt gets into the display window--can't see."

COMMENTS/POSSIBLE IMPROVEMENTS: Provide window covers, or otherwise modify the design to eliminate this problem.

Section 4: Labels

4.01 **OBSERVATION:** The front panel controls on both the frequency-hopping and backpack radio are numbered for reference purposes. (See also Observation 1.05.)

IMPACT: The numbers are useful for training and maintenance purposes, but only when the operator and maintenance manuals are used in conjunction with them. For the trained operator, however, the numbers only add uninformative clutter to the front panel.

COMMENTS/POSSIBLE IMPROVEMENTS: Even during training, the method of reference is unhandy. Operators and maintenance personnel should not have to refer to a list or key to identify controls or other operational features of the panel. The name of each control (etc.) should appear in low-contrast symbols on the front panel. (Control settings should appear in high-contrast symbols, as they do.)

4.02 **OBSERVATION:** The labels on the panels of the frequency-hopping and backpack radios are surface painted.

IMPACT: The labels may be prone to premature wear--although the face plate containing the labels appears to be easily replaceable. Sample operator comment: "I'm sure that the paint would wear off in a relatively short time. I think [the labels] should be imprinted into the material of the panel."

COMMENTS/POSSIBLE IMPROVEMENTS: The labels should be slightly impressed into the panel. This would protect the paint and still be resistant to the collection of dirt.

4.03 **OBSERVATION:** Some of the labels on the frequency-hopping and backpack radios are not presented in standard U.S. English idiom: "TEL," "FK," "ECCK," "0,15" "1,5" "0,1W," and "SEC." (See also Observation 1.08.)

IMPACT: The labels are more difficult for the U.S. English reader to learn and use. The use of a comma instead of a period to represent the decimal point appears strange (and may be confusing) to the U.S. operator. The meanings of the letter "K" (in "FK" and "ECCK") and the label "SEC" may not be understood.

COMMENTS/POSSIBLE IMPROVEMENTS: Replace the commas with points (periods). Change "FK" to "FF-CIPH" (or equivalent), "ECCK" to "ECC-CIPH" or "FH-CIPH" (or equivalent), and provide an appropriate substitute for "SEC."

4.04 **OBSERVATION:** The volume control is not adequately labeled on either the frequency-hopping or backpack radio, although a crescent scale is provided in each instance.

IMPACT: The function of the volume control is rather less apparent than the functions of most of the other controls, first, because the meaning of the crescent scale on the volume control may not be familiar to the operator/trainee and, second, because the same scale is also used on the combination squelch level/relay switch on the frequency-hopping radio and on the squelch control of the backpack radio.

COMMENTS/POSSIBLE IMPROVEMENTS: Label the volume controls with the term "VOLUME."

4.05 **OBSERVATION:** The emergency erase button on the frequency-hopping radio is not labeled.

IMPACT: This control, although important, may not be frequently used; therefore, operators may forget the emergency-erase procedure. If stored data should need to be erased by someone other than the operator, a label would be very helpful.

COMMENTS/POSSIBLE IMPROVEMENTS: Label the cap over the button or place the label on the panel nearby.

4.06 **OBSERVATION:** On the frequency-hopping radio, the "Thomson" label on the keyboard door is unnecessary.

IMPACT: The label adds clutter to the control panel and provides no operational information.

COMMENTS/POSSIBLE IMPROVEMENTS: Eliminate the label or move it from the front panel.

4.07 **OBSERVATION:** The label "F" (on the keyboard) and "FF" (on the operating mode switch), although different, have the same meaning.

IMPACT: The labels are inconsistent; the trainee/operator may assume that there is an unspecified difference between the meanings of the two labels.

COMMENTS/POSSIBLE IMPROVEMENTS: Change "F" to "FF," "FX FQ," or equivalent, ensuring consistency with all other instances and labels.

4.08 OBSERVATION: On the frequency-hopping radio keyboard, the label above the key for entering/storing data is "↓."

IMPACT: The label is ineffective and possible misleading, especially to the trainee or naive operator. (See also impact statement for Observation 4.09.)

COMMENTS/POSSIBLE IMPROVEMENTS: Change "↓" to "ENT." (Because the "store" function takes place automatically after the last "entry," the label "ENT" [as opposed to , say, "ENT/STO"] is probably sufficient.)

4.09 OBSERVATION: The label for "erase" on the frequency-hopping radio keyboard is "X."

IMPACT: The meaning of the label is not immediately clear to the trainee or other naive operator. (Instead of providing immediate cues about the functions they represent, labels like "X" and "↓" [Observation 4.08] must be learned. Hence, for the trainee or other naive operator, they constitute learning tasks rather than learning aids.)

COMMENTS/POSSIBLE IMPROVEMENTS: Change "X" to "CLEAR," "CLR," or other informative designation.

4.10 OBSERVATION: The squelch control on the frequency-hopping radio has the label "150 Hz" at the top. This label is centered over two settings and is intended to apply to both. (See also Observation 2.10.)

IMPACT: The intention of the label is not obvious to the naive operator. Whether "150 Hz" is meant to apply to the entire left side of the switch, to the top left setting, to the top left and top right settings, or to the entire switch is unclear.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide reference lines that illustrate the application of the switch, such as:

```
\--150 Hz--/              150 Hz        150 Hz
 \        /    ,                ■         ■          ,        or the like.
  ■      ■
```

4.11 OBSERVATION: The symbols on the frequency-hopping radio that are used to indicate "squelch on" and "squelch off" are not informative to the naive operator and are inconsistent with the labeling on the backpack radio. (See also Observation 2.10.)

IMPACT: Trainees and other naive operators will have unwarranted difficulty controlling the squelch feature on the frequency-hopping radio.

COMMENTS/POSSIBLE IMPROVEMENTS: Eliminate the squelch-on symbol entirely. Replace the squelch-off symbol with "SQUELCH OFF" or "SQ OFF."

4.12 OBSERVATION: On the frequency-hopping radio power switch, the symbol for "power off" is a circle.

IMPACT: The meaning of the label is not obvious to the trainee or other naive operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Replace the circle with the word "OFF."

4.13 OBSERVATION: On the frequency-hopping radio power switch, the label for the reception only condition (radio silence) is "RX."

IMPACT: The meaning of the label is not obvious to the trainee or other naive operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Change the label to "NO XMT," "NO TRANS," "RCV ONLY," "RAD SIL," or other appropriate indication.

4.14 OBSERVATION: On the backpack radio, the labels "MHz" and "kHz" are situated confusingly. The "MHz" label refers to frequency selector switches #1 and #2; yet it is placed between #2 and #3. The "kHz" label refers to switches #3, #4, and #5; it is located to the right of #5.

IMPACT: The trainee/operator will probably learn to ignore the label, because of their confusing locations.

COMMENTS/POSSIBLE IMPROVEMENTS: The switches, as a group, should be labeled "FREQUENCY SELECTOR SWITCHES," or the like. The "MHz" and "kHz" labels are unnecessary, but if desired, should be appropriately situated and possess reference lines, as follows:

```
                         FREQUENCY SELECTOR SWITCHES

   |------MHz------|             |-------------kHz-------------|
   |               |             |              |              |
 (x10)           (x1)         (x100)          (x10)          (x1)
   v               v             v              v              v

[Switch 1]     [Switch 2]     [Switch 3]     [Switch 4]     [Switch 5]
```

4.15 OBSERVATION: The reference lines for the antenna selector switch on the backpack radio give the impression that the switch is an in-line switch whose purpose is to make and break a circuit represented by the lines rather than to switch from one circuit to another.

IMPACT: Trainee/operator confusion.

COMMENTS/POSSIBLE IMPROVEMENTS: The markings would be improved if changed to something like the following:

```
                 -------- \|/
                           |

                       [Switch]
                                     |
                        50 Ohm --------|
```

or, preferably, rotate the toggle 90 degrees so that it moves left and right rather that up and down, and change the markings, as follows:

```
                 \|/
            ---   |  <---------> 50 OHM --|
                          |               |
                      [Switch]
```

4.16 **OBSERVATION:** The surface of the front panel on the backpack radio collects dirt easily, especially when wet.

IMPACT: The labels may become obscured.

COMMENTS/POSSIBLE IMPROVEMENTS: Perhaps a surface paint that is a little smoother than the primer-like paint currently used would help.

Section 5: Connectors and Cables

5.01 **OBSERVATION:** The most common complaint made by the operators pertaining to connectors was that the plugs were difficult to insert into the receptacles (see also Observation 5.02). An exception was the whip antenna connector and receptacle on the backpack radio, which were sturdy and easily utilized.

IMPACT: Excessive force was often required to make connections--an annoying waste of time. Depending on circumstances, the impact could vary from annoyance to a life-threatening problem.

COMMENTS/POSSIBLE IMPROVEMENTS: The design of certain plugs and sockets sometimes makes it physically difficult for operators to make connections quickly and easily, especially under adverse conditions (such as darkness, cold temperatures, wearing gloves, wearing NBC gear, etc.). Use only connectors that can be shown to be easily and reliably used under a variety of adverse circumstances.

5.02 **OBSERVATION:** The connector plugs and sockets are not adequately coded for easy alignment. The speaker and handset connectors have red reference marks (barely visible on the handset connector) for alignment, but the corresponding marks on the panel were obscured from view by the receptacle unless viewed from below the center line. Also, the marks

line up after (rather than before) the plugs are inserted. The red marks are at the bottom of the plugs and receptacles where they are most difficult to see--but they would be difficult to see from any perspective because they are rather fine.

IMPACT: Making connections is unnecessarily time-consuming and often a matter of trial and error.

COMMENTS/POSSIBLE IMPROVEMENTS: Employ appropriate shape and/or color coding on all connectors.

5.03 **OBSERVATION:** The 50 ohm antenna receptacles appear flimsy.

IMPACT: The receptacles may be overly susceptible to damage (bending, etc.)

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that these receptacles are resistant to deformation and are able to withstand considerable impact, especially on the backpack radio, which may be more abused.

5.04 **OBSERVATION:** Regarding the frequency-hopping radio, one operator noted: "The dust cover on the zero button needs to [be] metal. The plastic cover might be subject to more wear and will break off too easily, [allowing] something to hit the . . . button and clear the set."

IMPACT: The likelihood of this possibility is unknown, but see Observations 2.05 and 2.06.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the cap is durable and very unlikely to be lost.

5.05 **OBSERVATION:** On the frequency-hopping radio the 24-volt power supply receptacle is crowded close to the remote/relay/fill receptacle.

IMPACT: There is not enough space between the receptacles for the fingers when inserting the connectors.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase the distance between the receptacles.

5.06 **OBSERVATION:** The two audio receptacles on the frequency-hopping radio are too close to each other (approximately 1/2 inch).

IMPACT: Same as for Observation 5.05.

COMMENTS/POSSIBLE IMPROVEMENTS: Same as for Observation 5.05.

5.07 **OBSERVATION:** The rightmost audio receptacle on the frequency-hopping radio is too close to the corner panel guard (approximately 1/4 inch).

IMPACT: There is not enough space for the fingers when inserting a connector plug.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase the distance between the receptacle and the corner post.

5.08 **OBSERVATION:** The retaining clips on the caps for the audio receptacles on the frequency-hopping radio can extend beyond the top surface of the radio.

IMPACT: When extended beyond the top of the radio, the clips are vulnerable to damage.

COMMENTS/POSSIBLE IMPROVEMENTS: As a general rule, no feature of the panel should extend beyond any of the four sides of the radio.

5.09 **OBSERVATION:** The retaining clip on the antenna receptacle cap of the frequency-hopping radio extends to the outer rim of the cap.

IMPACT: The clip may be uncomfortable to the fingers while removing or installing the cap.

COMMENTS/POSSIBLE IMPROVEMENTS: Shorten the clip, or provide a different retaining method for the cap.

5.10 **OBSERVATION:** Two operator comments indicated that connecting the VINSON (KY-57) to the frequency-hopping radio was too complicated: (a) "In order to use Thomson and VINSON in [the] M113 [vehicle], there [are] <u>way</u> too many changes in wiring and [too many] hookups; many adapters were used and too many cables; (b) "Connecting the VINSON caused many problems [with] mismatched hookups."

IMPACT: Making the connection between the radio and the VINSON is, apparently, a procedure fraught with delay and frustration.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

5.11 **OBSERVATION:** On the backpack radio, the retaining straps on the protective caps tend to obstruct the use of adjacent controls and connectors.

IMPACT: Operators may break off the retainers in frustration. (Will the straps become brittle in extremely cold weather and thus break off easily?)

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that retaining straps on protective covers are so designed as not to interfere with operations.

5.12 **OBSERVATION:** The protective cap that covers both the antenna selector switch and the 50-ohm coaxial receptacle on the backpack radio slips off too easily.

IMPACT: The purpose of the cap, which is to protect the switch and receptacle, tends to be defeated.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a tighter-fitting cap.

5.13 **OBSERVATION:** The cap on the charger receptacle of the battery pack (ALI 116) is keyed so that it fits only one way, but the cap retaining strap does not permit free rotation of the cap for properly aligning the cap with its receptacle.

IMPACT: Using the cap is awkward. (See also Observation 5.14.)

COMMENTS/POSSIBLE IMPROVEMENTS: Allow the cap to rotate freely, or eliminate the need to install it in one orientation only.

5.14 **OBSERVATION:** Although the cap on the battery pack (ALI 116) charger receptacle is keyed so that it fits only one way, there are no alignment marks on the cap and receptacle to guide placement of the cap. (See also Observation 5.13.)

IMPACT: Same as for Observation 5.13.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide alignment keying or eliminate the requirement to install the cap with a particular orientation.

5.15 **OBSERVATION:** The retaining strap on the charger (ALI 116) receptacle cap causes the attachment screw to become loose when the strap is moved to allow easy alignment of the cap.

IMPACT: Whether the screw is captive or not was not determined. If not, it could be easily lost.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the screw is captive.

5.16 **OBSERVATION:** Two operator comments expressed a desire for a longer cord for the handset. (See also observation 5.17.)

IMPACT: The operator's freedom of movement may be overly restricted.

COMMENTS/POSSIBLE IMPROVEMENTS: Consider the advisability of lengthening the cord.

5.17 **OBSERVATION:** The handset cord and speaker cord for the backpack radio are not of coiled construction.

IMPACT: When not in use, the cords are too long, too inflexible, and too prone to tangling.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide coil cords.

5.18 **OBSERVATION:** The cable on the external speaker of the backpack radio is not well protected against wear at the point where it enters the speaker housing.

IMPACT: Premature cable wear.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide stress protection at the juncture of the cable and box.

Section 6: Operational Procedures

6.01 **OBSERVATION:** During operations (after data preparation is accomplished) the frequency-hopping-radio operator must press the display push-button in order to read display messages. One operator noted: When the signal for someone asking you to go to 'FR' or 'SYNC' . . . comes over the handset, you have to physically go to the radio and check the display to see exactly what is being asked of you."

IMPACT: The master station display does not automatically respond to cue or synchronization requests; therefore, it is necessary to manually activate the display to determine which request is being made. An inconvenience.

COMMENTS/POSSIBLE IMPROVEMENTS: The necessity to manually activate the display may be unnecessary. There appears to be no compelling reason why the display should not automatically indicate the nature of the request. This would allow the operator to determine visually the nature of the signal and eliminate a bothersome procedural step.

6.02 **OBSERVATION:** Access to the internal holding (data storage) battery in the frequency-hopping radio is through the front panel as is access to two 16 amp fuses.

IMPACT: These features are not involved in usual operating procedures; yet they occupy a considerable amount of space on the front panel that might be used to alleviate some of the crowding implied or alluded to in other observations (Observations 2.03-2.05 & 5.05-5.07).

COMMENTS/POSSIBLE IMPROVEMENTS: It may not be significantly detrimental to locate these compartments on a different surface.

Section 7: Communication

7.01 **OBSERVATION:** Operator's complained that it was impossible or difficult to communicate with or from a moving vehicle. Sample operator comments: (a) "Couldn't hear when vehicle was running. Couldn't receive or transmit when vehicle was moving"; (b) "From mounted [radio] to manpack while vehicle is moving, it is not possible to communicate"; (c) "Have problem communicating when moving"; (d) "Hard to hear a calling

[station] while vehicle [is] operating--suggest extension speaker to solve this."

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Part of the problem was certainly ambient noise; but there may have been other causes as well, such as interference from engine ignitions. The inability to communicate adequately in running or moving vehicles appears to be a common problem that deserves attention.

7.02 **OBSERVATION:** Some of the operators were dissatisfied with the range of the backpack radio--which might have been related to their parallel dissatisfaction with the backpack battery (see Observation 8.04): (a) "At a distance of 10 klicks [kilometers], it wouldn't pick up another manpack"; (b) "Cannot transmit at all after three miles, even on hilltops"; (c) "Power increase for better range is suggested; this manpack doesn't compare to mounted radios as far as power goes"; (d) "Reception was loud and clear most of the time, but had hard [time] when [we] moved to long distances."

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.03 **OBSERVATION:** Operator comments noted a significant ("serious," "large") decrement in the ability to communicate during bad weather (rain, electrical storms). Example: "Weather conditions play a big part on how well the radio works."

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.04 **OBSERVATION:** Several miscellaneous communication problems pertaining to interfacing with external equipment (VINSON [KY-57], DMD, external speaker, remote) were cited: (a) "KY seems to cause most problems with operation"; (b) "With VINSON on, the external speaker would emit the transmission, and nothing could be heard over the handset (approx. 30% of the time)--from what I was told, nothing should be heard over the external speaker while VINSON is on"; (c) "Vehicle . . . with DMD cannot transmit or receive DMD from other vehicles"; (d) "DMD would not function in ECC mode"; (e) "The handset would not function through the Thomson external speaker--I had to use the H-250 handset"; (f) "Transceiver would not operate through radio remote."

IMPACT: Degraded communications.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.05 **OBSERVATION:** One operator noted a problem communicating with the handset: "[The] main problem in my track (M113) was that if the handset was being used to communicate on radio, the CUC's [vehicles] would only be able [to] have intercom capabilities. If the CUC's were used to communicate on radio, you could not talk or listen on the radio with the handset. (Big Problem.) The squad leader uses the handset (or RTO [radio operator]) and the TC [tank commander] uses CUC's at the same time."

IMPACT: Apparently the operator implies that direct communication between the M113 and the CUC's could not be accomplished with the handset. The cause and precise nature of this problem were undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.06 **OBSERVATION:** Several miscellaneous operator comments dealt with various noises, tones, distortions, static, etc.: (a) "Having problem with sync. and beeping noise"; (b) "Received beeping while talking on frequency hopping; cannot find where it's coming from"; (c) "The radio beeped [and] nothing would show on display; there was no reason for one-third of the beeps"; (d) "Beeping noise makes your ears hurt [and causes a] headache"; (e) "Once again the radio was giving very low transmissions; radio also made a very disturbing noise which I had not heard . . . before; the noise was [a] buzzing sound that lasted for about 1 minute"; (f) "Making and receiving transmits a lot of distortion"; (g) "When trying to reach [a certain station] in secure mode, received static in mic."

IMPACT: Degraded communications. Either the operators in question were insufficiently trained regarding the meaning of the tone signals or the radio was producing spurious signals (the precise nature and extent of this problem was undetermined). Apparently the beep signals were so loud, so frequent, etc. that they were bothersome to some operators.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the radio does not emit beep tones that are not accompanied by a message on the display. Ensure that the volume of the tones is appropriate.

Section 8: Backpack Configuration

8.01 **OBSERVATION:** The backpack radio has no frequency-hopping function.

IMPACT: Communication between the frequency-hopping TRC 950 and the fixed-frequency TRC 577 is limited to fixed-frequencies. If the frequency-hopping radio is in one of the hopping modes (i.e., communicating with other frequency-hoppers in the net), the backpack radio will not be able to monitor the communications. If a frequency-hopping-radio operator wishes to communicate to the entire net (which contains one or more backpack radios), the message must be transmitted on a fixed frequency

to all net members or must be sent to frequency-hopping members in a hop mode and repeated in the fixed-frequency mode for the backpack radios.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a frequency-hopping, soldier-portable radio.

8.02 **OBSERVATION:** Although the 151 fold-away antenna is provided a containment pouch in the backpack, it has no containment device to prevent its unfolding when set aside temporarily before being stored in the pouch. (The same situation may exist with the 112B antenna, which was not examined.)

IMPACT: The folded antenna is awkward to handle. If it is not restrained, its segments will spring apart (unfold) automatically--an inconvenience.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide an integral clip or other device to contain the segments.

8.03 **OBSERVATION:** The backpack radio weighs approximately 4.9 kg (10.8 lbs).

IMPACT: Although not heavy by comparison standards, the radio does constitute a significant burden when considered along with other equipment that the soldier may carry.

COMMENTS/POSSIBLE IMPROVEMENTS: Every effort should be exerted to make soldier-portable radios as small and light as possible.

8.04 **OBSERVATION:** There were several operator complaints about the rechargeable ALI 116 backpack batteries (see also Observation 7.02): (a) "Poor quality of batteries used"; (b) "Problems with batteries"; (c) "Batteries burned out after 10 hours of use, which in turn caused massive static"; (d) "Batteries burn up in one day of transmission."

IMPACT: Loss of communications. Frequent changing of batteries.

COMMENTS/POSSIBLE IMPROVEMENTS: Battery life is a perennial problem. Use the longest-lasting batteries that are compatible with the overall system and ensure that fresh batteries are always available.

8.05 **OBSERVATION:** The fuse holder caps on the back panel of the backpack radio and on the ALI 116 battery are difficult to turn.

IMPACT: The fingers slip easily, making removal of the cap sometimes difficult and time consuming.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide a cap that is either larger or has better knurling (or both) so that it is easily grasped and turned. (But a larger cap would exacerbate the problem discussed in Observation 8.06.)

8.06 **OBSERVATION:** The fuse holder cap on the back panel of the backpack radio is too close to the spare fuse base.

IMPACT: The fingers hit the base when the fuse holder cap is turned, which interferes with removal of the fuse holder cap. (See Observation 8.05).

COMMENTS/POSSIBLE IMPROVEMENTS: Move the spare fuse base farther away from the fuse holder.

Section 9: Miscellaneous

9.01 **OBSERVATION:** Miscellaneous operator comment: "Sometimes when wanting to transmit, the Thomson CSF box goes haywire and won't transmit. Have to turn off and then back on."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

9.02 **OBSERVATION:** Neither the frequency-hopping radio nor the backpack radio are equipped with carrying handles.

IMPACT: The absence of carrying handles makes the radios cumbersome for operators or maintenance personnel to handle and more difficult to secure against unauthorized removal.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide handles.

9.03 **OBSERVATION:** The spare fuses in the keyboard cover on the frequency-hopping radio are not well secured.

IMPACT: Possible loss or damage to fuses.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide special compartment for fuses that prevent them from being exposed during normal operations.

9.04 **OBSERVATION:** The handsets evaluated were probably the COT 205-10 and the COT 206-10; the nomenclature did not appear on the external surface of the units.

IMPACT: Operators, maintenance personnel, and others apparently have no ready means (other than by recognizing external physical characteristics) to ascertain the exact identity of the handsets.

COMMENTS/POSSIBLE IMPROVEMENTS: For identification purposes, the nomenclature should appear prominently on the handset.

9.05 **OBSERVATION:** Two operator comments concerned the compatibility of handset with the "system": (a) "The Thomson handset would not work on VINSON"; (b) "Handset could not be hooked up into the system."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

TRANSWORLD: DETAILED OBSERVATIONS

The following observations derive from two sources: (a) written comments of the 13 soldiers trained to operate the Transworld radio; (b) the findings of two human factors specialists who independently assessed the operator-radio interface characteristics of the radio. The "comments" and "possible improvements" are offered as suggestions only. They are not necessarily exhaustive, sufficient, consistent with one another, or optimal. They may fail to take important factors into account such as cost, physical constraints, optimal overall design considerations, and doctrine.

Section 1: Operator's Manual

1.01 **OBSERVATION:** On a rating scale ranging from -100 (poor) to +100 (good), the Transworld manual ("Operator's and Organizational Maintenance Manual Including Repair Parts List," TW-PRC1077-TM1) was given the following scores by the reviewers (two human factors specialists): Content (+26); Readability (0); Illustration (+13); Durability (-100). An overall mean of -7 was obtained by weighting the four content areas by 1.00, .75, .50, and .50, respectively.

IMPACT: The overall mean indicated that the manual was considered fair in most respects. Areas receiving negative evaluations were the following: table of contents, operating instructions, paragraph length, sentence length, emphasis, number of illustrations, proximity of illustrations, clarity of illustrations, and durability.

COMMENTS/POSSIBLE IMPROVEMENTS: Revise accordingly.

1.02 **OBSERVATION:** The photocopied version of the manual presented for review suffered from bad reproduction.

IMPACT: Most of the illustrations were unclear.

COMMENTS/POSSIBLE IMPROVEMENTS: Student operators should not have to contend with documentation that is badly reproduced.

1.03 **OBSERVATION:** The manual includes both operating and organizational maintenance instructions.

IMPACT: The manual is inefficient in that it contains material not needed by both operators and maintainers.

COMMENTS/POSSIBLE IMPROVEMENTS: Consideration should be given to separating the operating and maintenance instructions into two manuals.

1.04 **OBSERVATION:** The manual refers to a "TUNE" channel (p. 3-31), but does not explain what it is. There is no such label on the radio itself.

IMPACT: Trainee confusion.

COMMENTS/POSSIBLE IMPROVEMENTS: Presumably the "TUNE" channel is the so-called "manual" channel, but the manual does not make it explicit. The manual should explain the term or eliminate it.

1.05 **OBSERVATION:** The manual (p. 3-2) incorrectly describes the procedure for entering the semi-duplex mode as follows: "Momentarily depress the handset push-to-talk switch."

IMPACT: Trainee confusion. Possible preclusion of communication in semi-duplex mode.

COMMENTS/POSSIBLE IMPROVEMENTS: The manual should state: "Depress the handset push-to-talk switch and hold while entering the transmit frequency using the standard procedure." Revise accordingly.

Section 2: Operating Controls

2.01 **OBSERVATION:** The front panel controls are not illuminated for use in low-light or no-light situations. Operators view this as a significant problem. (See also Observation 3.02.)

IMPACT: The lack of panel lighting makes it difficult or impossible for operators to manipulate the controls effectively in the dark without some sort of external light source, such as a flashlight, which may breach security.

COMMENTS/POSSIBLE IMPROVEMENTS: Consider providing back-lighting or side-lighting (not necessarily integral to the radio) for the front panel. In vehicles, the lighting might be incorporated into the radio mounts.

2.02 **OBSERVATION:** The radio has no power-on lamp.

IMPACT: There is no visual confirmation that power is present in the unit.

COMMENTS/POSSIBLE IMPROVEMENTS: A power-on lamp would be useful in the vehicular configuration for trouble-shooting and as a reminder to turn off the power at appropriate times.

2.03 **OBSERVATION:** Each control knob is retained by a single, non-captive, easily accessible Phillips-head screw.

IMPACT: An improperly tightened screw may vibrate loose. Knobs and screws may be lost and are subject to unauthorized removal.

COMMENTS/POSSIBLE IMPROVEMENTS: Retain knobs with two captive set screws spaced 90 degrees apart on side of knob.

2.04 **OBSERVATION:** The design of the control knobs and spindles allows the knobs to be installed 180 degrees from the correct position; i.e., they are not keyed for proper orientation during installation.

IMPACT: The knobs may be installed incorrectly and, in the case of the CHANNEL selector, can point to the wrong channel.

COMMENTS/POSSIBLE IMPROVEMENTS: Control knobs should be keyed so that they will not fit unless properly installed.

2.05 **OBSERVATION:** The knobs or their spindles tend to wobble slightly; i.e., the knobs feel loose.

IMPACT: The lack of positive feel may evoke a sense of inaccuracy when positioning a control.

COMMENTS/POSSIBLE IMPROVEMENTS: Switch action should be firm and precise.

2.06 **OBSERVATION:** When the MHz and KHz selectors are moved up or down to select frequencies, the display reacts too rapidly for some operators.

IMPACT: There is a tendency to overshoot desired frequency settings with the MHz and KHz selectors. Consequently, the operator has to "back up" to the correct setting.

COMMENTS/POSSIBLE IMPROVEMENTS: Two-speed switches would be helpful: When the switches are moved all the way, the frequency change should be rapid; when moved halfway, the frequency change should be slow.

2.07 **OBSERVATION:** Two operator criticisms pertained to the proximity of the MHz and power controls: (a) "MHz & power switches [are] too close together and can be confused in poor light"; (b) "[I] hit power switch when changing frequencies."

IMPACT: The problem constitutes primarily an annoyance. However, if the power switch were inadvertently moved from HI to MED (the most likely event), communication might be degraded or lost.

COMMENTS/POSSIBLE IMPROVEMENTS: The switch positions on the power switch could be changed, as, for example, in the following illustration, to minimize the probability of occurrence:

```
          ==@====> • HI
                  • MED
    OFF •        • LO
```

Ideally, the switch should be moved to the right (closer to the CHANNEL switch, which could also be moved farther to the right) and relabeled as follows:

```
   HI •
 MED • <====0==
   LO •
     OFF •
```

2.08 **OBSERVATION:** On the CHANNEL selector switch the stops at the beginning ("MAN") and end ("9") of the range were easily broken.

IMPACT: Once the stops are broken, the selector can rotate 360 degrees. The normally eliminated part of the range (counterclockwise between "MAN" and "9") appeared to contain two detents, at each of which (according to one of many negative operator comments) the display would read "impossible" frequencies.

COMMENTS/POSSIBLE IMPROVEMENTS: Improve the stops.

2.09 **OBSERVATION:** The CHANNEL switch can be set between channels. This is a specific violation of MIL-STD-1472C (par. 5.4.2.1.1.4.c), which specifies that switches should not be able to be stopped between settings.

IMPACT: Additional viable frequencies, which can be used for transmitting, can be stored between channels. While most operators would not be expected to discover this "hidden" capability, once it became known, it would provide a source of temptation to the curious.

COMMENTS/POSSIBLE IMPROVEMENTS: The switch detents should be redesigned to prohibit intermediate settings. (Incidentally, why are the additional channel possibilities obviously present in the radio not utilized?)

2.10 **OBSERVATION:** The spring tension on the CHAN SET button is rather stiff.

IMPACT: While loading frequencies into all 10 channels of the radio, the button must be depressed for considerable amounts of time and, hence, may become painful to the finger.

COMMENTS/POSSIBLE IMPROVEMENTS: Lessen the force required to hold the button in or provide an electronic (rather than mechanical) protection against accidental changing of the channel frequencies during normal operation.

2.11 **OBSERVATION:** The CHAN SET button does not protect the frequency in the "MAN" channel from accidental change as it does the frequencies in the other nine channels.

IMPACT: Possible accidental loss of frequency.

COMMENTS/POSSIBLE IMPROVEMENTS: Why this channel is not protected as the others are is not clear. An explanation in the manual would help. If the channel should be protected, then the feature should be redesigned.

2.12 **OBSERVATION:** The resistance (spring tension) on the function switch when moving the switch into the display-light position seems excessive.

IMPACT: The force required to activate the display light is sufficient to be bothersome to the operator.

COMMENTS/POSSIBLE IMPROVEMENTS: Lessen the required force.

2.13 **OBSERVATION:** When activating the display back-light, the function switch moves only about one-fourth the way from RETX to LITE.

IMPACT: The switch operates the light prematurely--an annoyance, which leaves the vague impression that the switch is malfunctioning.

COMMENTS/POSSIBLE IMPROVEMENTS: The position of the label "LITE" designates the proper switch position for activation of the display light. The movement of the switch should conform.

2.14 **OBSERVATION:** The display-light switch produces a "rushing" noise in the handset, which may be momentary or continuous, depending on how the switch is deployed. The sound (like "squelch off") occurs about midway of the switch travel. (A possibly related corollary is that, in order to light the display, the radio must be taken out of the squelch-on setting and put into the retransmission mode.)

IMPACT: The sound is annoying and the procedure is enigmatic.

COMMENTS/POSSIBLE IMPROVEMENTS: The precise cause of the noise is unknown, but it should be eliminated. The necessity to abandon squelch-on in order to light the display seems to be dictated only by the incorporation of these two unrelated functions into the same switch.

2.15 **OBSERVATION:** The VOLUME switch is a smooth-action rotary control with no detents except the stops at the ends of the movement range. However, the panel labeling around the knob (see also Observation 4.01) shows discrete steps.

IMPACT: The action of the control does not correspond to the labeling, which, accordingly, produces an unnecessarily complicated appearance.

COMMENTS/POSSIBLE IMPROVEMENTS: Either the knob action should be made into discrete, incremental steps or the labeling should be a continuous scale (such as a crescent). If the former, then the shape of the knob should be pointed to show the setting.

2.16 **OBSERVATION:** The handset pressel is on the side of the handset.

IMPACT: The switch is vulnerable to impact, wear, etc. in addition to being more difficult for left-handed operators to use.

COMMENTS/POSSIBLE IMPROVEMENTS: Put the switch on the inside of the handle.

Section 3: Display

3.01 **OBSERVATION:** The edges of the display can be read from a maximum of approximately 26 degrees above, 28 degrees below, 19 degrees to the left, and 19 degrees to the right.

IMPACT: It is impossible to read the edges of the display from operating positions outside the described perimeter. It is possible to misinterpret characters. One operator remarked that the frequencies in the display could not be seen from a normal (although askew) operating position.

COMMENTS/POSSIBLE IMPROVEMENTS: Increase viewing angles from all sides. Ideally, the display would allow viewing from about 45 degrees in all directions.

3.02 **OBSERVATION:** The back-lighted display was considered inadequate at nighttime by some operators.

IMPACT: One operator commented: "Transworld needs to put a switch on [the radio] so that the [display] can be turned on for night operations and stay on. In a tank, one cannot be fooling around with a light switch while moving, shouting, and communicating." Another operator noted: "Display should have its own lighted digits . . . . 'LITE' switch is hard to find at night. Display is easier [to] read by flashlight (if you have one)."

COMMENTS/POSSIBLE IMPROVEMENTS: The reduced visibility of controls at night is a frequent radio operator problem (see Observation 2.01). Consideration should be given to providing optional display lighting in vehicle configurations that stays on as long as the operator wishes. The problem may be exacerbated by the somewhat inconvenient display-light switch (see Observation 2.12).

3.03 **OBSERVATION:** The display does not capitalize on its potential for information presentation. Only frequencies are shown. (See also Observation 3.04.)

IMPACT: No display indication is available for battery condition, radio test results (see Observation 6.03), etc.

COMMENTS/POSSIBLE IMPROVEMENTS: Greater usage of the display would enhance the operability of the radio.

3.04 **OBSERVATION:** The display is a five-character (plus decimal) LCD with each character limited to seven segments. The display is therefore limited (especially because of the seven-segment limitation) in the

extent to which it could portray meaningful information to the operator. (See also Observation 3.03.)

IMPACT: For example, the display is incapable of portraying appropriate characters for the letters a, B, D, e, f, g, G, j, k, K, m, M, n, N, p, q, Q, r, R, s, t, T, v, V, w, W, x, X, y, Y, z, and Z. Furthermore, 5 and S would look the same, as would 6 and b and 0 (zero) and the letter O.

COMMENTS/POSSIBLE IMPROVEMENTS: A more versatile display type (e.g. dot matrix LED) would be an asset. However, the current display could be enhanced by the judicious use of alphabetical symbology.

3.05 **OBSERVATION:** The display window appears to be easily scratched.

IMPACT: The window may be prone to damage and degraded readability from physical abuse, especially in the backpack configuration. One operator commented: "I've noticed that the glass window on the frequency [display] has a few small scratches on it. Over a period of time, this may cause a problem in reading the frequencies."

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the display window is strong and sufficiently resistant to scratching.

Section 4: Labels

4.01 **OBSERVATION:** The labeling on the VOLUME control shows 11 discrete steps, indicated by white dots. The first dot (low volume) is numbered "1." The 6th dot is numbered "5." The 11th dot is numbered "10."

IMPACT: The labeling is not only inconsistent with the action of the switch (see Observation 2.15), it is also nonsensical.

COMMENTS/POSSIBLE IMPROVEMENTS: Even if the switch action were in stepwise increments, there would be more dots than necessary. Five to seven should be sufficient.

4.02 **OBSERVATION:** The label "MAN" on the channel selector is a misnomer. The term implies that the so-called "manual" channel is, unlike the other channels, somehow nonautomatic (i.e., operated manually). This distinction appears to be superfluous, having no bearing on the operating features of any of the channels.

IMPACT: Although the term is widely used, both new and seasoned operators tend to be confused about the purpose, proper usage, and nature of so-called "manual" channels.

COMMENTS/POSSIBLE IMPROVEMENTS: Replace the term with an appropriate and informative designator that connotes the administrative (or other) nature of the channel.

4.03 **OBSERVATION:** The labels on the control panel are embossed and surface-painted.

IMPACT: The paint on the labels is prone to wear.

COMMENTS/POSSIBLE IMPROVEMENTS: <u>Slightly</u> depressed labels would resist wear as well as the collection of dirt.

4.04 **OBSERVATION:** The label "LITE" on the the function switch and "LO" on the power switch are unnecessarily abbreviated (misspelled).

IMPACT: Although in this case the problem is minor (at least for those proficient enough in English to realize that "lite" is not the correct spelling of "light"), the use of unnecessary corruptions such as these tends to encourage the use of other inappropriate labeling shortcuts that are more indicative of laziness than economy of effort or function.

COMMENTS/POSSIBLE IMPROVEMENTS: There is ample room to spell out these simple labels.

4.05 **OBSERVATION:** The three squelch positions on the function switch are inadequately labeled.

IMPACT: The operator must remember that "RX TEST" means "squelch off," that "SQUELCH" means "noise squelch on," and that "TONE" means "TONE SQUELCH ON."

COMMENTS/POSSIBLE IMPROVEMENTS: More appropriate labeling might look like the following (note that the display light setting has been removed--see Observation 6.02):

```
                        RETX ■
           ¦------ TONE ■ <====@==
   SQUELCH ¦      NOISE ■
           ¦-- OFF/RX TEST ■
```

Section 5: Connectors and Cables

5.01 **OBSERVATION:** The power connector cover (BNC) must be on the power connector in order for the radio to operate on backpack battery power. The cover is attached to the radio by a braided cord.

IMPACT: The cord connections could be easily broken if they were to catch on an obstacle (e.g., underbrush). The cover could be lost (see Observation 5.02), which would make the radio inoperable.

COMMENTS/POSSIBLE IMPROVEMENTS: That the power connector cover should be securely attached to the radio goes without saying. Despite that, the operability of the radio should not be dependent on the security of

the cover. Some other means of disengaging the battery circuit for vehicular operation should be devised.

5.02 **OBSERVATION:** When not in place, the connector caps hang aimlessly on their attachment cords.

IMPACT: The caps sometime obstruct the view of operators or maintenance personnel; they may interfere with operating and maintenance procedures; they may snag on other objects, especially in the backpack version; they may be easily lost. Also, the retaining cords are easily broken.

COMMENTS/POSSIBLE IMPROVEMENTS: The method of attaching the caps is a common method, perhaps used for the lack of a ready solution. However, connector caps attached in this manner are problematical, and a better solution should be sought. Protective covers that are integral to the radio (and thus not subject to loss), yet do not interfere with procedures and handling would be very desirable.

5.03 **OBSERVATION:** The retaining cord on the protective antenna-connector receptacle cap gets in the way when screwing the cap on.

IMPACT: The amount of work involved just to install the cap on the antenna-connector receptacle is excessive.

COMMENTS/POSSIBLE IMPROVEMENTS: Perhaps a rubber plug would better suffice in this case.

5.04 **OBSERVATION:** The protective caps on the audio connectors slip off too easily.

IMPACT: An annoyance.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide tighter-fitting caps (but see also Observation 5.02, Comment).

5.05 **OBSERVATION:** The antenna connector appears to be less sturdy than the other connectors.

IMPACT: The extent to which the antenna receptacle is prone to being damaged is unknown. The antenna may break at the mount if it is not screwed in tightly.

COMMENTS/POSSIBLE IMPROVEMENTS: Ensure that the connector and antenna base will withstand the normal rigors of the battlefield.

5.06 **OBSERVATION:** Apparently the installation of cables was ill-considered.

IMPACT: These operator comments were obtained: (a) "Cables (T-cable) in way of dials & knobs on PRC 1077 (also KY-57 cables in way)"; (b) "T-cable from J-box to radio obstructs the view of frequencies"; (c) "T-cables too close to switches . . . ; they interfere with some knobs";

(d) "T-cable from the J-box obstructed display view; cables from KY-57 were too long"; (e) "Power and audio cables are too long on KY-57"; (f) "The radio cable from KY-57 to manpack needs to be shortened."

COMMENTS/POSSIBLE IMPROVEMENTS: Reroute and shorten cables to minimize interference with the operator's view and operations.

5.07 **OBSERVATION:** The design of the interface between the battery box and the radio is conducive to battery damage.

IMPACT: The connector socket on the magnesium battery (BA-4386/U) can be seriously damaged if the battery is removed at an angle rather than straight up.

COMMENTS/POSSIBLE IMPROVEMENTS: Removal of the battery should be guided by the physical design of the box-to-radio interface so that it is impossible to twist the battery out of position until the battery terminals have cleared the connector.

5.08 **OBSERVATION:** With the battery and battery box removed from the radio, the connector pins on the radio are exposed to impact from foreign objects.

IMPACT: The connector pins could be inadvertently damaged during maintenance or battery changing procedures.

COMMENTS/POSSIBLE IMPROVEMENTS: The pins should be protected from impact by a metal shielding rim.

5.09 **OBSERVATION:** The connector of the handset (H-250-U) often requires considerable effort to install.

IMPACT: Operator frustration and wasted time. Operators often use saliva as a lubricant on the connector pins (which could itself be a problem in very cold weather).

COMMENTS/POSSIBLE IMPROVEMENTS: This particular type of connector/plug interface has long been in need of redesign. At times it is very difficult to make the connection because of the great force that must be applied to the plug before rotating it into the locked position. The use of this old-fashioned connector by the Army should be phased out as soon as possible.

Section 6: Operational Procedures

6.01 **OBSERVATION:** The frequency- setting procedure requires at least two hands: Although awkward, it is possible to set the MHz portion of the frequencies with one hand; setting the KHz, however, requires two hands.

IMPACT: The procedure can be very cumbersome, especially in the dark. The operator needs one hand for holding the CHAN SET button in, two for setting the frequency, another for holding the "LITE" switch to illuminate the display, another for depressing the push-to-talk switch (if the semi-duplex mode is desired), and another to attend to required documentation (e.g., a CEOI). Operator comments included the following: (a) "[The] operator needs three hands to program frequency [because the] display light and frequency switches [are] in different places. A flashlight was more convenient"; (b) "The PRC-1077 has the capability to set 10 channels. This would be easy during daylight, but [not] in dusk or dark conditions, because it would be difficult to hold the light switch, press the channel set button, and move the KHz or MHz selectors all at the same time"; (c) "Frequency settings for presets take two hands; one hand is usually occupied with a CEOI, etc."

COMMENTS/POSSIBLE IMPROVEMENTS: To the extent possible, all procedures should be designed so that they can be accomplished with one hand.

6.02 **OBSERVATION:** The display-light switch is located on the function switch.

IMPACT: The operator is forced to turn the function switch out of the current setting (RX TEST/squelch off, SQUELCH, TONE, RETX) in order to operate the display light.

COMMENTS/POSSIBLE IMPROVEMENTS: The operation of the display light should be independent of other function switch settings. Therefore the display-light switch might better be an independent control located elsewhere on the panel.

6.03 **OBSERVATION:** The radio provides no self-test capability.

IMPACT: The operator must perform transceiver tests manually, some of which tend to be very time consuming and cumbersome. For example, the test for power output requires three radios (one to be checked and two others known to be in good operating condition to create a comparison standard).

COMMENTS/POSSIBLE IMPROVEMENTS: A self-test capability with displayed results (see Observation 3.03) would eliminate the necessity for employing primitive test procedures.

6.04 **OBSERVATION:** Battery and power output checks require long transmission periods. The operator's manual (p. 5-1) says: "Normal battery operation can be accelerated by holding the transceiver in the High Power transmit mode for 2 or 3 minutes before starting operations."

IMPACT: The operator may unwittingly compromise station position with long transmissions.

COMMENTS/POSSIBLE IMPROVEMENTS: The length of transmissions should be minimized. Operational procedures that require long transmission times should be revised.

6.05 OBSERVATION: The radio cannot be set for semi-duplex operation by following the procedure specified in the operator's manual.

IMPACT: See Observation 1.05.

COMMENTS/POSSIBLE IMPROVEMENTS: See Observation 1.05.

6.06 OBSERVATION: One operator offered the following comment pertaining to operating from the tank commander's position: "My normal operating position is standing in the tank commander's cupola. I have to kneel down to look at the radio many times on the move. I need to be able to see without taking more than a few seconds." Many tank commanders have noted the same problem in the past. They apparently consider it a significant problem.

IMPACT: The tank commander is, in essence, forced to temporarily abandon his observation post in order to control the radio.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

6.07 OBSERVATION: Finger access to the battery case latches was poor, making the latches very difficult to release.

IMPACT: Changing the battery is unnecessarily time consuming, irksome, and hard on the fingers.

COMMENTS/POSSIBLE IMPROVEMENTS: The latches need to be redesigned to allow easy (but not accidental) disengagement.

Section 7: Communication

7.01 OBSERVATION: Apparently there was a notable problem communicating in secure (VINSON KY-57) with the Digital Message Device (DMD). Operator comments: (a) "PRC1077, with DMD, will not function correctly with KY-57 on secure mode;" (b) "Would not work DMD with KY-57--not a fault of radio"; (c) "We had problems with secure and DMD--digital traffic could not be passed. Bad commo was experienced in secure mode one-fourth of the time."

IMPACT: Considerable degradation of communication.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

7.02 OBSERVATION: The operators voiced several complaints related to the power amplifier: (a) "The power amp causes considerable battery drain on the M151 batteries"; (b) "The power amplifier kept preventing us from

operating effectively due to . . . [illegible] . . . during high power setting. The problem had to be overcome by keying the hand mike twice before each transmission;" (c) "RF amp caused power to drain"; (d) "RF amp [produced] humming sound periodically."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: The causes of the problems alluded to were undetermined.

7.03 **OBSERVATION:** One operator noted: "The volume control on the radio needs to be examined again; with the VINSON on, there would be no change of volume when the volume control was turned."

IMPACT: Inadequate or inefficient control of volume.

COMMENTS/POSSIBLE IMPROVEMENTS: The volume control on the radio should always work, regardless of what ancillary equipment may be attached.

7.04 **OBSERVATION:** Three operator comments cited the backpack battery as a "large problem." Although the operators did not specify the precise nature of the battery problem, it is presumed that they were referring to experienced communication difficulties due either to battery failure or to the idiosyncrasies of the magnesium battery used. (See also Observation 7.05.)

IMPACT: Degradation of communication.

COMMENTS/POSSIBLE IMPROVEMENTS: One may infer from the operator's manual that the magnesium battery is quite temperamental. The manual states: "The magnesium battery BA-4386/U does not deliver full power immediately. If the receiver does not operate immediately, wait for 30-60 seconds for the battery to produce sufficient output voltage. In the transmit mode, the battery output may fall below the operating level when the push-to-talk switch is depressed. Wait at least 10 seconds before speaking to ensure the battery has recovered. Full output power may not be reached for 30-60 seconds." Consideration should be given to using a different battery if it is common for the magnesium battery to cause the sort of difficulties described. In critical situations, operators may not be able to spare the time and trouble to "work around" the operational requirements of this battery.

7.05 **OBSERVATION:** The following operator comments are related to the problems discussed in Observation 7.04, but deal specifically with the effects of low battery power: (a) "Whenever I'd [press the] push-to-talk button, [the radio] would jump from the frequency it was on to another frequency"; (b) "Batteries in radio keep going dead; I went through five of them. When battery gets low and you key radio, the frequencies change, and if you are not looking you will be transmitting on wrong channel, and you may have to re-key it two or three times."

IMPACT: Degradation of communication.

COMMENTS/POSSIBLE IMPROVEMENTS: See Observation 7.04, Comment.

7.06 **OBSERVATION:** One operator reported: "PRC1077 had difficulty transmitting and receiving on high level bands; had to go to low band."

IMPACT: Limited frequencies for communication.

COMMENTS/POSSIBLE IMPROVEMENTS: Whether the problem cited was caused by a characteristic of the radio or was due to external factors was not determined.

Section 8: Miscellaneous

8.01 **OBSERVATION:** On the back of the examined radio, the rim that accepts the battery box (CY-2562) had been bent slightly inward, apparently from an impact on the top surface of the radio casing. Although the case appeared to have been repainted, the gouged metal on the outside of the battery housing rim was obvious.

IMPACT: The battery box did not easily slip into the rim on the radio.

COMMENTS/POSSIBLE IMPROVEMENTS: If rough handling is capable of producing the kind of damage observed, the back rim on the radio should be constructed from heavier gauge metal.

8.02 **OBSERVATION:** One operator said: "[The radio] is not applicable to the needs of a radio in a tank. . . . [It doesn't] hook up to the remote system."

IMPACT: Undetermined.

COMMENTS/POSSIBLE IMPROVEMENTS: Undetermined.

8.03 **OBSERVATION:** Two operators criticized the installation of the VINSON (KY-57) in the backpack configuration: (a) "Too heavy, and the KY-57 needs a way to be mounted on better"; (b) "With the VINSON mounted right behind the radio, the straps are too short. . . . If they want to use the VINSON on the manpacks, they should make a place to put it on the backpack itself."

IMPACT: Non-standard procedures. Unwieldy loads.

COMMENTS/POSSIBLE IMPROVEMENTS: Provide means for appropriate, standard installation that meets the requirements of MIL-STD-1472C, Section 5.11.

SUMMARY AND CONCLUSIONS

This report of research summarizes the MANPRINT assessment of ten manufacturers' nondevelopmental tactical net radios that was conducted by the ARI Fort Hood Field Unit during a two-month operational assessment at Fort Riley, Kansas in the fall of 1986. Among the ten radios was the ITT SINCGARS, which constituted a baseline against which the other radios were compared.

Data were obtained in five areas: trainability, operability, skills and knowledge retention, adequacy of operator manuals, and human factors. The results included rank orderings of the ten radios in terms of trainability, operability, and quality of operator manuals. The retention data were limited to the ITT SINCGARS radio--a separate results section, incorporating previous research results concerning SINCGARS learning decay, is provided. Finally, for all of the radios, a comprehensive human factors assessment was conducted; those findings, based upon the written comments of field observers as well as the detailed inspections of the ARI human factors specialists, were presented in separate sections for each radio.

In general, the results indicated that the ITT radio compared rather unfavorably on the training dimension--it was the lowest ranked of the radios and judged to be somewhat below the "fair" point on a scale ranging from "good" to "poor." On the dimension of operability, the ITT radio was located precisely in the middle of the scale ("fair") and ranked fourth (from the bottom) in the list of ten radios. ITT's operator manual was judged to be "fair" overall in comparison with the other manuals presented, its worst score being associated with a lack of durability; it was ranked number five out of ten.

The human factors aspects of the ITT radio had been evaluated in detail on two previous occasions. Those findings were reviewed, and, where still applicable, incorporated into the present report. No formal human factors comparison was made between the ITT radio and the others. The list of findings pertaining to the ITT radio consisted of 8 observations pertaining to the operator's manual, 9 pertaining to operating controls, 2 pertaining to the display, 18 pertaining to labeling, 7 pertaining to connectors and cables, 12 pertaining to operating procedures, 2 pertaining to communication, and 3 miscellaneous.

The ITT retention results indicated tentatively that soldiers may lose about ten percent of their performance proficiency within the first few weeks after a period of intensive training and experience lasting for several weeks. Performance levels were found to be moderately correlated with ASVAB GT scores, but performance decay was not.

Additional research needs to performed in the realm of training--not to determine whether or not the training produces "adequate" performance (according to all indications, it does) but rather whether the training, which is considerably more time consuming and complicated than that required for ITT SINCGARS precursors (the VRC-12 and PRC-77 radios), can be made more efficient and less costly, both in time and money.

Table 1

Summary Demographics: Operators and Data Collectors

MOS		N	Mean SQT	Mean GT	Mean time in MOS (months)	Mean prior RT operation experience[a]
11B	Infantryman	47	83	110	16	3.5
19E	Armored Crew Member	23	75	105	62	4.0
31K	Combat Signaler	16	72	106	27	4.6
12C	Bridge Crew Member	12	73	104	19	3.7
31V	Tac Commo Sys Opr/Mech	7	75	107	22	4.3
31C	Single Chan Radio Opr	6	69	109	34	4.7
12A	Armor Officer, General	2	NA	NA	13	4.5
31M	Multichannel Commo Opr	2	81	103	29	4.5
11C	Indirect Fire Infantryman	1	86	--	46	--
12B	Armor Officer	1	NA	NA	--	5.0
27E	TOW/DRAGON Repairman	1	--	110	14	1.0
35K	Avionic Mechanic	1	--	99	11	4.0
36C	Wire Sys Installer/Opr	1	--	95	36	4.0
93P	Flight Opns Coordinator	1	--	128	4	3.0
	Total:	(121)				
	Overall Mean:		(79)	(108)	(28)	(3.9)

[a]The numbers in this column refer to a 5-point scale (1 to 5), where 1 = "Very little, or none"; 2 = "A little (a little training, no significant experience)"; 3 = "Some (a few hours of experience)"; 4 = "Fair amount ('hands-on' experience and/or training)"; and 5 = "A lot (including formal training)".

Table 2

Demographic Data by Assessment Cycle and Vendor: Operators and Data Collectors

Cycle	Radio	MOS	N[a]	Mean SQT[b]	Mean GT[b]	Mean time in MOS (months)[b]	Mean prior RT operating experience[bc]
1	HAR	11B	10	82	110	19	3.6
		19E	2	84	108	81	3.5
			(12)	(82)	(109)	(29)	(3.6)
	ROC	11B	10	78	107	16	3.7
		12A	1	NA	NA	16	5.0
		19E	1	--	99	11	5.0
			(12)	(78)	(106)	(15)	(3.9)
2	RAC	11B	5	88	116	25	4.0
		12C	6	82	108	16	3.7
		19E	1	62	85	228	4.0
			(12)	(83)	(109)	(38)	(3.8)
	THO	11B	4	84	117	14	4.7
		11C	1	86	--	46	--
		12C	6	69	100	22	3.7
		19E	1	79	111	180	5.0
			(12)	(78)	(107)	(35)	(4.2)
3	ITT	11B	3	85	108	12	3.3
		12B	1	NA	NA	--	5.0
		19E	3	75	107	23	3.3
		31C	3	68	112	32	4.7
		31V	1	--	123	7	5.0
		93P	1	--	128	4	3.0
			(12)	(78)	(112)	(19)	(3.9)
	MAR	11B	3	88	98	12	3.0
		19E	6	79	105	34	4.0
		31V	2	82	108	44	4.0
		35K	1	--	99	11	4.0
			(12)	(83)	(103)	(28)	(3.8)

[Continued on next page]

Table 2, continued

Demographic Data by Assessment Cycle and Vendor:
Operators and Data Collectors

Cycle	Radio	MOS	N[A]	Mean SQT[B]	Mean GT[B]	Mean time in MOS (months)[B]	Mean prior RT operating experience[BC]
4	ERI	11B	3	79	119	13	3.0
		19E	2	74	108	87	4.5
		27E	1	--	110	14	1.0
		31K	5	86	101	25	5.0
		36C	1	--	95	36	4.0
			(12)	(79)	(107)	(32)	(4.0)
	TAD	11B	3	81	115	13	2.0
		19E	2	76	109	25	4.5
		31K	4	67	102	26	3.8
		31M	2	81	103	29	4.5
		31V	1	--	115	3	4.0
			(12)	(75)	(107)	(21)	(3.6)
5	SEL	11B	3	85	102	11	3.3
		19E	3	66	101	88	3.0
		31C	2	74	117	36	4.5
		31K	2	70	104	27	4.5
		31V	3	71	99	19	4.5
			(13)	(75)	(104)	(37)	(3.8)
	TWC	11B	3	87	115	11	3.0
		12A	1	NA	NA	10	4.0
		19E	2	73	112	47	4.5
		31C	1	64	86	36	5.0
		31K	5	70	116	29	4.8
			(12)	(78)	(112)	(27)	(4.4)

[A]Numbers in parentheses are sums within vendors.
[B]Numbers in parentheses are means within vendors.
[C]The numbers in this column refer to a 5-point scale (1 to 5), where 1 = "Very little, or none"; 2 = "A little (a little training, no significant experience)"; 3 = "Some (a few hours of experience)"; 4 = "Fair amount ('hands-on' experience and/or training)"; and 5 = "A lot (including formal training)".

Table 3.1

Post-Training MANPRINT Evaluation Questionnaire Results: DISPLAY

> Note: Questionnaire items 1 through 69 used a 7-point scale ranging from +3 ("Extremely good") to -3 ("Extremely poor").

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
001. Location on panel.										
M:	+1.9	+2.2	+2.6	+2.4	+2.4	+2.1	+2.1	+2.1	+1.6	+2.5
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.5	0.8	0.6	0.6	0.8	0.8	0.9	0.9	0.9	0.6
002. Color of characters.										
M:	+1.9	+1.8	+2.9	+2.5	+2.2	+1.7	+2.2	+1.8	+1.7	+1.9
N:	12	12	12	12	12	12	13	12	12	13
SD:	1.1	1.1	0.3	0.7	0.8	0.7	0.6	0.7	1.1	0.8
003. Brightness range (illumination).										
M:	+1.7	+2.7	+2.8	+3.0	+2.5	+1.7	+2.4	+1.2	+1.5	+1.9
N:	12	12	12	12	12	12	13	12	12	13
SD:	1.6	0.4	0.4	0.0	0.8	0.9	0.6	1.3	1.0	0.9
004. Reflections (absence of).										
M:	+1.7	+1.2	+2.3	+2.2	+2.1	+2.0	+2.0	+1.5	+1.3	+1.6
N:	12	12	11	12	11	12	13	12	12	13
SD:	1.1	0.7	0.8	0.8	0.8	1.0	1.0	1.0	1.0	0.9
005. Flicker (absence of).										
M:	+1.7	+2.2	+2.7	+2.2	+2.3	+1.8	+2.1	+2.1	+1.9	+1.7
N:	12	12	10	12	11	12	12	12	11	13
SD:	1.2	0.7	0.6	0.7	0.6	1.4	1.0	0.6	0.9	0.9

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Table 3.1, continued

Post-Training MANPRINT Evaluation Questionnaire Results: DISPLAY

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
006. Readability (normal distance).										
M:	+2.3	+2.5	+2.8	+2.8	+2.7	+2.5	+2.4	+1.5	+2.4	+2.3
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.9	0.7	0.4	0.4	0.6	0.8	0.6	1.7	0.9	0.7
007. Readability (6-foot distance).										
M:	+1.5	+1.9	+2.2	+1.9	+1.9	+1.7	+2.0	+0.5	+1.6	+1.8
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.9	1.0	0.8	1.0	1.2	0.8	1.1	1.4	1.3	1.0
008. Readability from side angle.										
M:	+1.0	+0.4	+1.6	+2.1	+1.9	+1.1	+1.4	+0.6	+0.4	+1.0
N:	12	12	12	12	12	12	13	12	12	13
SD:	1.4	1.2	1.3	0.6	1.0	0.9	1.2	1.6	1.4	1.0
009. Readability from high angle (looking down).										
M:	+1.0	+0.6	+1.2	+1.5	+1.7	+1.2	+1.3	+1.7	+0.1	+1.3
N:	12	12	12	12	12	12	13	12	12	13
SD:	1.6	1.8	1.3	0.6	1.2	1.2	1.1	1.5	1.2	1.1
010. Readability from low angle (looking up).										
M:	+1.2	+0.4	+1.2	+1.7	+1.5	+1.2	+1.2	+1.2	+0.0	+1.5
N:	12	12	12	12	12	12	13	12	12	13
SD:	1.2	1.3	1.2	0.9	1.1	0.8	1.3	1.6	1.1	0.8
011. Readability with classroom lighting.										
M:	+2.4	+2.5	+2.7	+3.0	+2.7	+2.7	+2.5	+1.7	+2.0	+1.8
N:	12	12	12	12	12	12	13	12	11	13
SD:	0.9	0.7	0.4	0.0	0.6	0.5	0.8	0.9	0.9	0.8
012. Display self-test.										
M:	+2.5	+2.6	+2.8	+2.7	+2.6	+2.7	+2.7	+2.5	+1.6	NA
N:	12	12	12	12	11	12	12	12	12	NA
SD:	0.7	0.6	0.4	0.4	0.5	0.4	0.5	0.7	1.1	NA

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Table 3.1, continued

Post-Training MANPRINT Evaluation Questionnaire Results: DISPLAY

013. Display-failure indication.

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
M:	+2.3	+2.2	+2.3	+2.4	+2.0	+2.7	+2.6	+2.5	+1.7	NA
N:	12	12	12	12	12	12	13	12	10	NA
SD:	0.8	1.0	0.6	0.6	0.8	0.4	0.6	0.8	1.2	NA

014. Design of characters (numbers/letters/symbols).

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
M:	+2.3	+2.7	+2.3	+2.6	+2.0	+2.5	+1.8	+1.7	+1.7	+1.9
N:	11	12	12	11	12	12	13	12	11	13
SD:	0.8	0.6	0.9	0.8	0.9	0.5	1.0	0.9	1.1	1.0

015. Meaningfulness (understandability) of words, abbreviations, etc.

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
M:	+2.2	+2.0	+1.9	+2.4	+1.7	+2.7	+0.8	+2.0	+1.0	+2.4
N:	12	12	12	11	12	12	12	12	12	13
SD:	0.8	1.1	0.8	0.8	1.0	0.6	1.8	0.8	1.5	0.7

016. Feedback information (clear?).

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
M:	+1.9	+1.5	+2.2	+2.3	+2.1	+2.2	+2.0	+1.9	+1.7	+1.6
N:	12	12	12	12	12	12	13	12	12	11
SD:	1.0	1.2	0.7	0.6	0.8	0.8	0.9	1.8	1.0	1.1

017. Feedback information (enough?).

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
M:	+1.8	+1.2	+1.6	+2.2	+2.2	+1.8	+2.0	+1.9	+1.5	+1.5
N:	12	12	12	12	12	12	13	12	12	11
SD:	0.8	1.2	1.0	0.8	0.6	1.3	1.0	0.9	1.1	1.0

018. Error feedback (adequate?).

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
M:	+1.7	+1.3	+1.9	+2.2	+2.2	+2.0	+1.4	+2.0	+1.4	+1.4
N:	12	12	12	12	12	12	12	12	12	11
SD:	1.1	1.0	1.1	0.9	0.7	1.0	1.2	0.8	1.3	1.0

019. Prompts/reminders (enough?).

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
M:	+1.5	+1.1	+1.2	+2.0	+2.2	+2.1	+1.4	+1.6	+1.7	+1.5
N:	10	12	12	12	12	12	13	12	12	11
SD:	1.4	1.4	1.1	0.9	0.8	0.8	0.9	1.1	1.2	1.0

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Table 3.1, continued

Post-Training MANPRINT Evaluation Questionnaire Results: DISPLAY

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
020. Display reaction time.										
M:	+1.1	+1.2	+2.2	+2.3	+2.4	+1.9	+1.8	+1.7	+1.9	+1.5
N:	12	12	12	12	12	12	13	12	12	13
SD:	2.1	1.7	0.8	0.9	0.6	1.2	1.2	1.1	0.6	0.9
021. Overall display complexity.										
M:	+2.0	+1.7	+1.9	+2.3	+2.0	+2.4	+2.2	+2.0	+1.8	+2.0
N:	12	11	12	12	12	12	12	12	12	13
SD:	0.8	0.9	1.3	0.6	0.7	1.0	0.9	0.7	0.8	1.0
022. Overall display design (format, layout).										
M:	+2.3	+2.0	+1.8	+2.5	+2.2	+2.5	+2.2	+1.7	+1.9	+1.9
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.6	0.9	0.9	0.5	0.8	0.7	0.7	1.1	0.8	1.0
023. Overall display quality.										
M:	+2.2	+2.0	+2.0	+2.5	+2.5	+2.5	+2.1	+2.1	+1.6	+2.0
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.7	0.7	0.9	0.5	0.7	0.7	0.8	0.9	1.0	1.0

Table 3.2

Post-Training MANPRINT Evaluation Questionnaire Results: CONTROL KNOBS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
024. Location/arrangement on panel (logical?).										
M:	+2.2	+2.0	+1.8	+2.4	+2.1	+2.6	+1.4	+1.3	+1.2	+2.4
N:	12	12	12	10	11	12	13	10	12	12
SD:	0.7	0.7	0.9	0.7	0.9	0.6	0.9	1.3	0.8	0.8
025. Accessibility/spacing (uncrowded?).										
M:	+1.8	+0.8	+0.9	+2.3	+0.9	+1.7	+0.6	+0.4	+0.5	+2.0
N:	12	12	12	10	12	12	12	10	12	13
SD:	1.4	1.8	1.1	0.8	1.6	1.6	1.3	1.6	1.0	0.9
026. Color contrast (with panel background).										
M:	+1.9	+1.6	+1.9	+2.4	+1.9	+1.8	+2.2	+1.4	+1.7	+1.9
N:	12	12	12	10	12	12	13	10	12	13
SD:	1.0	1.1	0.8	0.8	0.6	1.0	0.8	0.8	1.3	0.8
027. Knob shape shows which end is the pointer (normal straight-on view).										
M:	+1.9	+1.7	+1.7	+2.3	+2.1	+1.9	+1.8	+1.9	+1.6	+2.0
N:	12	12	12	10	12	12	13	10	12	13
SD:	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.4	0.9
028. Knob shape shows which end is the pointer (from other views).										
M:	+2.0	+1.7	+1.5	+2.7	+1.4	+1.6	+1.5	+2.1	+1.4	+1.9
N:	12	12	12	10	12	12	13	10	12	13
SD:	0.8	1.2	1.0	0.5	1.2	1.1	1.0	1.3	1.2	1.0
029. Knob shape helps to identify settings by "feel."										
M:	+1.2	+0.2	+1.0	+1.6	+1.9	+1.7	+1.3	+0.8	+0.3	+1.5
N:	12	12	12	10	12	12	13	10	12	13
SD:	1.4	2.2	1.6	1.1	1.0	1.1	1.1	1.8	1.8	1.1
030. Visibility of reference markings on knobs, if any (from normal view).										
M:	+1.6	+2.1	+2.0	+2.1	+1.7	+1.7	+2.0	+1.9	+1.2	+1.5
N:	12	12	12	10	12	12	13	10	12	13
SD:	1.0	0.6	1.0	0.8	0.9	1.0	0.8	1.3	1.0	0.8

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Table 3.2, continued

Post-Training MANPRINT Evaluation Questionnaire Results: CONTROL KNOBS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
031. Visibility of reference markings on knobs, if any (from other views).										
M:	+1.5	+0.7	+1.5	+1.9	+1.3	+2.4	+1.5	+1.9	+1.1	+1.8
N:	12	12	11	10	12	12	13	10	12	13
SD:	1.0	1.4	1.1	0.9	1.0	1.0	1.0	1.2	0.9	0.6
032. Size (appropriate?).										
M:	+2.2	+1.5	+2.0	+2.3	+2.1	+2.0	+1.6	+1.7	+1.7	+1.6
N:	12	12	11	9	12	12	13	10	12	13
SD:	0.7	1.6	0.9	0.7	0.8	0.8	1.3	1.9	1.2	0.8
033. Resistance to damage/wear (sturdiness).										
M:	+1.8	+0.0	+2.1	+1.7	+2.0	+2.0	+1.7	+0.9	+1.0	+1.9
N:	12	11	12	10	12	12	13	9	10	13
SD:	0.9	2.0	0.8	0.8	0.8	0.9	1.1	1.7	1.6	1.1
034. Force required to move (appropriate resistance?).										
M:	+1.8	+1.2	+1.8	+2.1	+2.2	+2.1	+1.4	+0.7	+1.2	+1.9
N:	11	12	12	9	12	12	12	10	11	13
SD:	1.2	1.6	1.1	0.9	1.2	0.8	1.3	1.7	1.4	0.7
035. Range of movement (too large/small?).										
M:	+2.1	+1.2	+2.2	+2.3	+1.9	+1.8	+1.4	+0.8	+1.3	+1.7
N:	10	12	12	10	12	12	12	10	12	13
SD:	0.5	1.5	0.6	0.8	0.9	1.1	1.3	1.8	1.1	0.7
036. Knobs stop at end of range.										
M:	+2.4	+1.3	+2.4	+2.4	+2.5	+1.7	+1.5	+2.3	+2.1	+0.8
N:	12	12	12	10	12	12	13	10	11	13
SD:	0.6	1.8	0.5	0.7	0.8	0.9	1.2	0.9	1.1	1.7
037. Resistance to accidental movement.										
M:	+1.3	+0.8	+2.4	+1.5	+2.5	+1.7	+2.1	+1.6	+1.8	+1.9
N:	11	12	11	10	12	11	11	9	12	13
SD:	1.2	1.9	0.8	0.9	0.8	1.2	1.3	1.6	1.1	0.9

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Table 3.2, continued

Post-Training MANPRINT Evaluation Questionnaire Results: CONTROL KNOBS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
038. Detents--i.e., "click" stops at settings (too soft/hard?).										
M:	+1.7	+0.9	+1.7	+2.2	+2.2	+1.7	+1.8	+1.5	+1.7	+1.5
N:	12	12	12	9	12	12	13	10	12	12
SD:	1.2	1.6	1.1	0.8	1.2	1.5	1.2	1.1	0.7	1.3
039. Appropriate interlocks (stops) to prevent over shooting or accidentally going beyond desired setting.										
M:	+1.2	+0.2	+2.3	+0.5	+2.7	+1.2	+1.3	+1.8	+2.0	+1.1
N:	12	12	12	10	12	12	12	10	10	13
SD:	1.4	1.9	0.6	2.1	0.4	1.3	1.6	1.2	1.3	1.2
040. Good "feel."										
M:	+1.7	+1.4	+2.2	+1.9	+2.2	+2.4	+1.4	+2.0	+2.0	+1.8
N:	12	12	12	10	12	12	13	9	11	13
SD:	1.2	1.0	1.0	0.7	1.0	0.9	1.4	1.1	0.7	0.7

Table 3.3

Post-Training MANPRINT Evaluation Questionnaire Results: TOGGLE AND/OR BUTTON SWITCHES

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
041. Location (convenient?).										
M:	NA	+2.0	NA	+2.4	NA	NA	NA	+2.1	+1.3	+1.7
N:	NA	12	NA	12	NA	NA	NA	11	3	13
SD:	NA	0.8	NA	0.6	NA	NA	NA	0.9	1.3	0.9
042. Size.										
M:	NA	+0.7	NA	+2.6	NA	NA	NA	+1.5	+1.3	+1.8
N:	NA	12	NA	12	NA	NA	NA	10	3	13
SD:	NA	1.8	NA	0.5	NA	NA	NA	1.8	1.3	1.0
043. Resistance to damage (sturdiness).										
M:	NA	-0.3	NA	+2.0	NA	NA	NA	+1.8	+1.7	+1.9
N:	NA	12	NA	12	NA	NA	NA	10	3	13
SD:	NA	2.0	NA	0.7	NA	NA	NA	1.1	0.9	0.7
044. Resistance to accidental switching.										
M:	NA	+1.9	NA	+2.0	NA	NA	NA	+1.7	+2.7	+1.8
N:	NA	12	NA	12	NA	NA	NA	10	3	13
SD:	NA	1.3	NA	1.0	NA	NA	NA	1.0	0.5	1.0
045. Good "feel" (snap, click).										
M:	NA	+1.6	NA	+2.1	NA	NA	NA	+2.1	+2.0	+1.8
N:	NA	12	NA	12	NA	NA	NA	10	3	13
SD:	NA	1.0	NA	1.1	NA	NA	NA	0.9	0.8	1.1
046. Labels (clear/understandable).										
M:	NA	+1.9	NA	+2.4	NA	NA	NA	+1.6	+1.3	+2.2
N:	NA	12	NA	12	NA	NA	NA	10	3	13
SD:	NA	0.9	NA	0.6	NA	NA	NA	0.9	1.3	0.8
047. Ease of operation.										
M:	NA	+2.4	NA	+2.7	NA	NA	NA	+2.2	+0.0	+2.6
N:	NA	12	NA	12	NA	NA	NA	10	3	13
SD:	NA	0.6	NA	0.5	NA	NA	NA	0.9	2.2	0.7

Table 3.4

Post-Training MANPRINT Evaluation Questionnaire Results: KEYBOARD (KEYPAD)

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
048. Location of keypad (convenient?).										
M:	+2.4	NA	+2.6	NA	+2.5	NA	NA	+2.2	+2.0	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	0.6	NA	0.6	NA	0.8	NA	NA	0.7	0.8	NA
049. Keys (sturdy? resistant to wear/damage?).										
M:	+2.1	NA	+1.5	NA	+2.0	NA	NA	+1.9	+1.3	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	1.1	NA	1.4	NA	1.2	NA	NA	1.1	1.7	NA
050. Separation between keys (satisfactory for operation without mittens?).										
M:	+1.5	NA	+1.7	NA	+1.6	NA	NA	+1.8	+1.9	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	1.5	NA	1.2	NA	1.3	NA	NA	0.8	1.2	NA
051. Size of keys (adequate?).										
M:	+1.8	NA	+2.0	NA	+1.7	NA	NA	+1.7	+1.3	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	0.9	NA	0.7	NA	1.1	NA	NA	1.0	1.3	NA
052. Surface friction on keys (prevents finger slippage).										
M:	+1.9	NA	+2.2	NA	+2.4	NA	NA	+2.1	+2.0	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	1.4	NA	0.7	NA	0.8	NA	NA	1.2	1.1	NA
053. Feedback (can "feel" when key has been pressed).										
M:	+1.5	NA	+2.3	NA	+2.5	NA	NA	+0.6	+1.2	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	1.5	NA	0.6	NA	0.7	NA	NA	1.6	1.4	NA
054. Good "feel."										
M:	+1.7	NA	+2.3	NA	+2.2	NA	NA	+1.4	+0.9	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	1.2	NA	0.6	NA	0.7	NA	NA	1.0	1.4	NA

[Continued on next page]

Table 3.4, continued

Post-Training MANPRINT Evaluation Questionnaire Results: KEYBOARD (KEYPAD)

> Note: The following three questions used different 5-point scales ranging from 1 (most favorable) to 5 (least favorable).

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
055. Does the display show something when a key on the keypad is pressed?										
M:	2.2	NA	1.5	NA	1.2	NA	NA	1.5	1.3	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	1.4	NA	0.7	NA	0.4	NA	NA	1.1	0.4	NA
056. Are any of the keys used for anything that is not indicated by a label on the key?										
M:	1.6	NA	1.1	NA	1.6	NA	NA	1.3	1.2	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	0.6	NA	0.3	NA	0.5	NA	NA	0.5	0.6	NA
057. Does the keypad offer enough features? I.e., will it do enough things required for efficient operation?										
M:	1.9	NA	1.4	NA	1.3	NA	NA	1.5	1.6	NA
N:	12	NA	12	NA	12	NA	NA	12	12	NA
SD:	0.4	NA	0.5	NA	0.4	NA	NA	0.7	0.6	NA

Table 3.5

Post-Training MANPRINT Evaluation Questionnaire Results: CONNECTOR PLUGS AND SOCKETS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
058. Location.										
M:	+2.1	+1.5	+1.4	+2.5	+1.9	+2.2	+1.5	+0.3	+1.6	+1.9
N:	12	12	12	12	12	12	12	12	12	13
SD:	0.6	1.4	1.3	0.9	0.6	1.0	1.2	1.8	1.0	0.9
059. Spacing (for easy grasp).										
M:	+1.8	+0.7	+0.5	+1.8	+1.2	+2.5	+1.7	+0.1	+0.5	+1.5
N:	12	12	12	12	12	12	12	12	12	13
SD:	0.7	2.0	1.1	1.0	1.5	1.3	1.2	1.9	1.8	0.8
060. Sturdiness (resistance to damage).										
M:	+2.1	+2.0	+1.9	+1.9	+2.0	+1.7	+1.8	+2.0	+1.1	+2.1
N:	12	12	11	12	12	12	12	12	12	13
SD:	0.8	0.8	1.4	0.9	0.7	1.5	1.3	0.9	1.4	0.7
061. Coding (dot, arrow, etc., to show proper alignment for insertion).										
M:	+1.6	+1.2	+1.4	+2.2	+0.4	+1.2	+2.2	+1.3	+1.5	+1.5
N:	12	12	12	12	12	12	12	12	12	13
SD:	0.9	1.1	1.3	1.1	1.3	1.3	0.9	1.7	1.2	1.0
062. Keying (impossible to put plug in wrong socket).										
M:	+1.7	+1.2	+0.4	+2.1	+2.2	+2.0	+1.9	+1.5	+1.6	+1.6
N:	11	12	12	12	12	12	12	12	12	13
SD:	1.3	1.5	1.3	1.0	0.8	0.9	1.2	1.4	1.4	0.8
063. Alignment (can insert plug in socket only one way).										
M:	+2.1	+1.8	+2.2	+2.5	+2.6	+2.2	+2.4	+1.5	+1.9	+1.9
N:	12	12	12	12	12	12	12	12	12	13
SD:	1.1	1.0	0.7	0.8	0.6	0.7	0.9	1.7	1.3	0.7
064. Labels (clear identification of connectors).										
M:	+2.3	+2.4	+2.1	+2.6	+2.2	+2.2	+2.2	+1.7	+1.2	+1.8
N:	12	11	12	12	12	12	12	12	12	13
SD:	0.8	0.8	1.0	0.6	0.8	1.0	1.3	1.0	1.1	0.8

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Table 3.5, continued

Post-Training MANPRINT Evaluation Questionnaire Results: CONNECTOR PLUGS AND SOCKETS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
065. Easy connection/removal (force).										
M:	+1.5	+1.8	+0.4	+2.4	+1.7	+1.7	+2.1	+1.9	+0.3	+1.6
N:	11	12	12	12	12	12	12	11	12	13
SD:	1.0	1.0	1.5	0.8	1.1	1.5	1.3	2.1	1.5	0.8
066. Quick connection/removal (one-turn).										
M:	+1.7	+2.1	+1.6	+2.5	+1.6	+1.7	+2.2	+0.9	+0.7	+1.6
N:	12	12	12	12	12	12	12	12	12	13
SD:	1.4	0.5	1.1	0.7	1.1	1.2	1.2	2.0	1.2	0.8
067. Dust covers (durability/well-secured).										
M:	+1.5	+1.5	+1.7	+1.4	+1.7	+2.2	+1.8	+0.4	+1.3	+1.3
N:	12	12	12	12	12	12	12	12	12	13
SD:	1.7	2.0	1.2	1.7	1.0	0.7	1.2	1.3	1.3	0.9
068. Plugs/cables do not obstruct view of front panel.										
M:	+1.9	+2.0	+2.1	+2.3	+1.9	+2.2	+2.7	+1.5	+1.7	+1.5
N:	12	12	12	12	12	12	12	12	12	13
SD:	0.6	1.1	0.6	0.9	0.9	1.2	0.6	0.7	1.2	0.7
069. Plugs/cables do not obstruct operation of controls.										
M:	+2.1	+1.8	+2.3	+2.4	+1.7	+1.7	+2.7	+2.2	+1.7	+2.2
N:	12	12	12	12	12	12	12	12	12	13
SD:	0.6	1.3	0.5	0.9	1.3	1.6	0.6	0.8	1.2	0.6

Table 3.6

Post-Training MANPRINT Evaluation Questionnaire Results: PROCEDURES

Note: Questionnaire items 70 through 112 used a 7-point scale ranging from +3 ("Extremely easy") to -3 ("Extremely difficult").

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
070. Connecting/disconnecting battery.										
M:	+2.4	+2.8	+2.4	+1.8	+2.2	+2.6	+2.5	+1.3	+0.7	+2.3
N:	12	12	8	12	9	12	11	12	8	13
SD:	0.9	0.4	0.9	1.7	0.8	0.6	0.7	1.9	1.2	0.8
071. Connecting/disconnecting antenna.										
M:	+2.1	+2.6	+2.1	+2.5	+2.7	+2.2	+2.0	+2.2	+2.3	+2.5
N:	12	12	11	12	12	12	13	12	12	13
SD:	1.0	0.6	2.0	1.0	0.6	1.2	1.0	0.7	1.2	0.6
072. Connecting/disconnecting handset.										
M:	+2.2	+2.4	+2.2	+2.9	+2.2	+2.3	+2.5	+2.1	+0.8	+1.7
N:	12	12	12	12	12	12	13	12	11	13
SD:	1.1	0.8	0.8	0.3	0.7	0.8	0.6	1.2	1.8	1.2
073. Connecting VINSON.										
M:	NA	+1.7	+0.9	+2.6	+1.7	+1.5	NA	NA	NA	+2.2
N:	NA	11	12	12	12	12	NA	NA	NA	13
SD:	NA	1.4	1.7	0.6	1.2	1.6	NA	NA	NA	0.8
074. Setting VINSON controls.										
M:	NA	+1.8	+2.1	+2.6	+1.8	+1.8	NA	NA	NA	+2.1
N:	NA	11	12	12	12	12	NA	NA	NA	13
SD:	NA	0.9	1.2	0.5	1.2	0.8	NA	NA	NA	0.9

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Table 3.6, continued

Post-Training MANPRINT Evaluation Questionnaire Results: PROCEDURES

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
075. Turning on RT.										
M:	+2.5	+2.3	+2.6	+3.0	+2.3	+2.1	+2.3	+2.2	+2.2	+2.1
N:	11	11	12	9	11	12	12	12	11	11
SD:	0.7	0.8	0.6	0.0	1.0	1.0	0.8	1.0	1.0	1.0
076. Adjusting display brightness.										
M:	+2.2	+2.7	+3.0	+2.8	NA	NA	+0.2	NA	NA	NA
N:	12	12	12	12	NA	NA	5	NA	NA	NA
SD:	1.2	0.4	0.0	0.4	NA	NA	2.1	NA	NA	NA
077. Adjusting volume.										
M:	+2.5	+2.5	+3.0	+2.8	+2.1	+2.4	+2.5	+2.4	+2.4	+2.4
N:	12	12	12	12	12	11	13	11	12	13
SD:	0.7	1.1	0.0	0.4	0.9	0.7	1.1	0.6	0.6	0.7
078. Determining/setting squelch condition.										
M:	NA	+2.5	+2.9	NA	NA	+2.3	+2.5	+2.3	+1.9	+2.1
N:	NA	12	12	NA	NA	12	12	12	10	13
SD:	NA	0.7	0.3	NA	NA	0.6	0.9	0.8	0.8	0.8
079. Doing a battery test/check.										
M:	+2.1	+2.6	+3.0	+2.6	+1.9	+2.8	+2.3	+2.4	NA	NA
N:	10	12	11	10	11	12	12	12	NA	NA
SD:	0.7	0.6	0.0	0.8	1.0	0.4	0.9	0.8	NA	NA
080. Testing for fault in RT.										
M:	+2.3	+2.7	+2.9	+2.8	+2.0	+2.9	+2.4	+2.5	+1.6	NA
N:	11	12	12	9	11	12	12	12	7	NA
SD:	0.8	0.5	0.3	0.4	1.1	0.3	0.9	0.7	0.9	NA
081. Setting/loading time.										
M:	+2.4	+2.4	+2.5	+2.5	NA	+2.1	+2.2	+1.9	+1.8	NA
N:	12	11	12	11	NA	12	9	12	9	NA
SD:	0.6	0.7	0.8	0.7	NA	0.9	0.9	1.1	1.0	NA

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Table 3.6, continued

Post-Training MANPRINT Evaluation Questionnaire Results: PROCEDURES

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
082. Loading net ID.										
M:	+2.3	+2.4	+2.6	+2.9	NA	+2.3	+2.3	+1.8	+1.9	NA
N:	12	11	10	8	NA	12	11	12	12	NA
SD:	0.5	0.8	0.5	0.3	NA	0.8	0.9	1.0	1.0	NA
083. Loading frequency (non-secure).										
M:	+2.4	+2.5	+2.7	+2.7	+2.7	+2.1	+2.4	+2.2	+2.2	+2.3
N:	12	11	12	12	12	12	11	12	12	10
SD:	0.6	0.5	0.6	0.5	0.5	0.8	0.9	0.8	0.8	0.9
084. Establishing net.										
M:	+2.2	+2.1	+1.8	+2.7	+2.2	+1.9	+2.3	+2.0	+2.0	+2.1
N:	12	12	12	12	12	12	13	12	11	13
SD:	0.8	0.8	1.2	0.4	1.1	0.9	0.8	0.9	0.9	0.9
085. Entering net.										
M:	+2.2	+2.3	+1.8	+2.7	+2.2	+2.0	+2.3	+2.0	+2.2	+2.1
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.7	0.8	1.2	0.4	1.0	1.0	0.8	0.8	0.7	0.9
086. Synchronizing RT with NCS.										
M:	+1.8	+2.3	+0.7	+2.7	+2.3	+1.9	+2.3	+2.5	+2.5	NA
N:	12	10	12	11	12	12	13	12	12	NA
SD:	1.1	0.8	1.9	0.5	0.9	1.0	0.9	0.8	0.7	NA
087. Obtaining desired display.										
M:	+1.9	+2.5	+2.2	+2.6	+2.5	+2.3	+2.5	+2.0	+2.2	+1.9
N:	12	12	12	12	12	12	11	12	12	11
SD:	0.8	0.7	0.7	0.8	0.7	0.6	0.9	0.9	0.9	1.0
088. Using handset.										
M:	+2.1	+2.5	+2.7	+2.8	+2.5	+2.7	+2.7	+2.5	+2.2	+2.2
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.9	0.7	0.6	0.4	0.7	0.6	0.8	0.5	0.7	1.1

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Table 3.6, continued

Post-Training MANPRINT Evaluation Questionnaire Results: PROCEDURES

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
089. Loading frequency (secure).										
M:	+2.2	+2.4	+2.2	+2.6	+2.7	+2.0	+2.3	+2.3	+2.3	NA
N:	12	11	12	12	12	12	6	10	12	NA
SD:	0.7	0.7	1.0	0.6	0.5	0.8	0.8	0.8	0.8	NA
090. Sending ECCM fill.										
M:	NA	NA	+1.7	NA	NA	NA	NA	NA	NA	NA
N:	NA	NA	9	NA	NA	NA	NA	NA	NA	NA
SD:	NA	NA	0.7	NA	NA	NA	NA	NA	NA	NA
091. Receiving and storing ECCM fill.										
M:	NA	NA	+2.2	NA	NA	NA	NA	NA	NA	NA
N:	NA	NA	9	NA	NA	NA	NA	NA	NA	NA
SD:	NA	NA	0.8	NA	NA	NA	NA	NA	NA	NA
092. Loading hopset (secure).										
M:	+2.2	+2.4	+2.1	+2.8	NA	NA	NA	+2.2	+1.8	NA
N:	12	11	11	12	NA	NA	NA	10	12	NA
SD:	0.7	0.6	1.0	0.5	NA	NA	NA	0.8	1.7	NA
093. Responding to cue/page/rescue.										
M:	+2.2	+2.2	+2.3	+2.6	+2.4	+2.3	NA	+2.0	+1.8	NA
N:	10	8	12	9	9	12	NA	12	12	NA
SD:	0.9	1.0	0.6	0.7	0.8	0.9	NA	0.9	1.2	NA
094. Late entry into net.										
M:	+2.2	+2.1	+0.9	+2.7	+2.3	+1.5	+2.4	+1.6	+1.5	NA
N:	12	12	12	12	12	12	10	11	12	NA
SD:	0.7	1.0	1.7	0.6	0.9	1.0	0.8	0.9	1.0	NA
095. Re-establishing contact with NCS.										
M:	+2.1	+2.2	+1.6	+2.8	+2.2	+1.7	+2.6	+1.9	+1.3	NA
N:	12	12	12	12	12	12	10	12	12	NA
SD:	1.0	0.9	1.0	0.4	0.9	0.8	0.5	1.0	1.3	NA

Table 3.7

Post-Training MANPRINT Evaluation Questionnaire Results: AUDIO TASKS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
096. Carrying RT (manpack).										
M:	+2.0	+1.4	+1.5	+1.0	+1.4	+1.2	+2.7	+1.5	+1.0	+1.8
N:	12	11	6	10	10	11	12	11	5	9
SD:	0.9	1.4	1.0	1.8	1.0	2.0	0.4	1.2	1.1	0.9
097. Understanding voice communications (single channel).										
M:	+2.2	+2.6	+2.7	+2.5	+2.2	+2.1	+2.7	+2.5	+2.3	+2.5
N:	12	12	12	12	12	12	13	12	11	13
SD:	0.6	0.6	0.5	0.5	0.7	0.8	0.6	0.8	0.6	0.6
098. Understanding voice communications (frequency hopping).										
M:	+2.4	+2.6	+2.6	+2.3	+2.2	+1.9	NA	+2.4	+2.1	NA
N:	12	12	12	12	12	12	NA	12	11	NA
SD:	0.5	0.6	0.5	0.6	0.7	1.0	NA	0.8	0.8	NA
099. Recognizing a tone signal.										
M:	+2.1	+1.9	+1.7	+2.3	+2.4	+1.7	+2.6	+2.5	+2.0	NA
N:	12	12	12	12	12	12	11	12	12	NA
SD:	1.0	0.6	0.7	0.9	0.6	0.9	0.6	0.8	0.9	NA
100. Understanding a tone signal.										
M:	+1.7	+2.0	+1.3	+2.3	+2.4	+1.7	+2.5	+2.4	+1.9	NA
N:	12	12	12	12	12	12	11	12	12	NA
SD:	1.0	1.0	0.8	0.9	0.5	1.2	0.7	0.9	1.0	NA
101. Avoiding static interference.										
M:	+1.9	+1.4	+2.0	+2.0	+1.8	+1.4	+2.3	+1.9	+1.8	+1.8
N:	12	11	11	12	12	12	10	11	12	11
SD:	0.9	1.6	0.7	0.7	1.1	1.0	0.8	1.3	1.0	0.6
102. Avoiding interference from other stations.										
M:	+1.7	+1.5	+2.2	+2.4	+2.2	+1.2	+2.4	+2.2	+1.9	+1.8
N:	11	12	10	12	12	12	11	11	12	11
SD:	1.1	1.4	0.8	0.8	1.0	1.2	0.8	1.5	1.0	0.2

[Continued on next page]

Table 3.7, continued

Post-Training MANPRINT Evaluation Questionnaire Results: AUDIO TASKS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
103. Controlling volume.										
M:	+2.4	+2.1	+2.3	+2.5	+2.2	+2.3	+2.7	+2.2	+2.1	+2.3
N:	12	12	12	12	12	12	12	12	12	13
SD:	0.8	1.4	0.8	0.7	0.7	0.8	0.6	0.9	0.9	0.7
104. Recognizing synchronization.										
M:	+1.7	+2.2	+1.4	+2.7	+2.4	+2.1	NA	+2.5	+1.9	NA
N:	11	11	12	12	12	12	NA	12	12	NA
SD:	1.4	0.9	1.8	0.5	0.6	0.9	NA	0.7	1.3	NA

Table 3.8

Post-Training MANPRINT Evaluation Questionnaire Results: VISUAL TASKS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
105. Controlling brightness.										
M:	+2.0	+2.7	+2.9	+2.8	NA	NA	+1.2	NA	NA	NA
N:	12	12	12	12	NA	NA	8	NA	NA	NA
SD:	1.5	0.4	0.3	0.4	NA	NA	1.9	NA	NA	NA
106. Obtaining information from display.										
M:	+2.3	+2.4	+2.2	+2.5	+2.2	+2.5	+2.7	+1.9	+2.2	+2.3
N:	12	12	12	12	12	12	13	12	12	11
SD:	0.9	0.8	1.2	0.7	0.7	0.7	0.6	1.0	0.7	0.9
107. Understanding display prompts.										
M:	+1.9	+2.3	+2.3	+2.5	+2.3	+2.5	+2.6	+1.9	+1.2	NA
N:	12	12	11	12	11	12	13	12	12	NA
SD:	0.9	0.9	1.0	0.7	0.6	0.5	0.5	1.0	1.6	NA
108. Recognizing a cue/page/rescue.										
M:	+1.7	+2.2	+2.7	+2.2	+2.4	+2.4	NA	+2.3	+1.8	NA
N:	10	6	12	9	8	12	NA	10	12	NA
SD:	1.0	1.2	0.5	0.8	0.7	1.0	NA	1.0	0.8	NA
109. Distinguishing between numbers.										
M:	+2.6	+2.6	+2.7	+2.2	+2.7	+2.5	+2.4	+2.2	+1.9	+2.1
N:	11	12	12	12	12	12	13	12	12	12
SD:	0.5	0.6	0.6	0.9	0.5	0.9	0.7	1.2	1.0	1.0
110. Distinguishing between letters.										
M:	+2.3	+2.4	+1.9	+2.2	+2.4	+2.1	+2.2	+1.9	+1.9	NA
N:	11	11	12	12	12	12	9	12	12	NA
SD:	1.0	0.7	1.4	0.9	0.8	1.0	0.9	1.3	0.9	NA
111. Distinguishing between numbers and letters.										
M:	+2.4	+2.4	+2.4	+1.8	+2.4	+2.3	+2.3	+2.0	+1.7	NA
N:	11	11	12	12	12	12	10	12	12	NA
SD:	0.8	0.7	0.8	1.1	0.8	0.9	1.0	1.0	1.2	NA

[Continued on next page]

Table 3.8, continued

Post-Training MANPRINT Evaluation Questionnaire Results: VISUAL TASKS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
112. Recognizing end-of-test (Bit) operation.										
M:	+2.5	+1.5	+2.9	+2.2	+2.6	+2.2	+2.9	+2.1	+0.9	NA
N:	10	10	11	12	10	11	11	12	7	NA
SD:	0.7	1.0	0.3	0.9	0.5	1.0	0.3	1.0	1.1	NA

Table 3.9

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR MANUALS

> Note: Unless indicated by asterisks (*), the means below are based on scales ranging from "a" (most favorable) to "e" (least favorable), where "a" = 1 and "e" = 5. Means with asterisks are based on bipolar scales in which the center of the scale ("c") was the most favorable response, while "a" and "e" were the least favorable responses.

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
113. Is the print size easy to read?										
M:	1.5	1.7	1.5	1.5	1.9	1.7	NA	1.9	1.8	1.6
N:	11	10	12	12	12	12	NA	12	12	13
SD:	0.6	0.6	0.5	0.5	0.5	0.5	NA	0.5	0.7	0.6
114. The number of illustrations (figures, tables, etc.) was:										
M:	3.8*	3.1*	3.1*	3.2*	3.3*	2.8*	NA	2.8*	3.5*	2.8*
N:	11	10	12	12	12	12	NA	12	12	13
SD:	0.9	0.3	0.3	0.7	0.4	0.4	NA	0.8	0.7	0.6
115. Were the illustrations clear?										
M:	3.0	2.4	1.9	1.7	2.0	1.6	NA	2.1	2.1	1.7
N:	11	10	12	12	12	12	NA	12	12	13
SD:	1.2	0.7	0.5	0.6	0.6	0.5	NA	0.5	1.0	0.5
116. The number of pictures in the manual was:										
M:	4.5*	3.2*	3.1*	3.3*	3.6*	3.1*	NA	3.0*	3.3*	3.2*
N:	11	10	12	12	12	12	NA	12	12	13
SD:	0.8	0.4	0.3	0.9	0.6	0.3	NA	0.9	0.8	0.4

[Continued on next page]

*See note at beginning of table.

Table 3.9, continued

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR MANUALS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
117. Were the pictures helpful?										
M:	3.3	2.3	1.8	1.9	1.8	1.6	NA	2.0	2.4	1.6
N:	12	10	12	12	11	12	NA	12	12	13
SD:	1.5	0.8	0.4	1.0	0.6	0.6	NA	0.8	0.9	0.8
118. Were the illustrations helpful?										
M:	3.2	2.3	1.6	1.9	1.8	1.3	NA	1.8	2.5	1.7
N:	12	10	12	12	12	12	NA	12	12	13
SD:	1.5	0.9	0.5	0.5	0.4	0.5	NA	0.8	0.9	0.8
119. The arrangement/spacing of material on the page was:										
M:	2.2	2.4	2.0	1.6	2.2	2.0	NA	2.1	2.3	1.8
N:	12	10	12	12	12	12	NA	12	12	13
SD:	0.6	0.5	0.8	0.6	0.8	0.4	NA	0.3	0.9	0.4
120. The wording of the manual was:										
M:	2.8*	3.1*	3.1*	2.8*	2.8*	3.0*	NA	3.0*	2.4*	3.2*
N:	12	10	12	12	12	12	NA	12	12	13
SD:	0.4	0.3	0.3	0.9	0.4	0.0	NA	0.4	0.6	0.4
121. Does the manual cover enough material?										
M:	3.3*	3.3*	3.1*	3.1*	2.9*	3.0*	NA	3.1*	3.0*	3.0*
N:	12	10	12	12	12	12	NA	12	12	13
SD:	0.8	0.5	0.3	0.6	0.3	0.0	NA	0.6	1.1	0.0
122. The organization of material (information, sequence of tasks, illustrations, etc.) in the manual was:										
M:	2.5	2.2	2.2	1.9	1.9	2.0	NA	2.4	2.8	1.9
N:	12	10	12	12	12	12	NA	12	12	13
SD:	0.9	0.4	0.7	1.2	0.8	0.6	NA	0.5	0.7	0.5

[Continued on next page]

*See note at beginning of table

Table 3.9, continued

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR MANUALS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
123. Were the summaries (reviews) in the manual helpful?										
M:	NA	3.1	2.0	NA	NA	2.4	NA	NA	3.8	2.2
N:	NA	9	12	NA	NA	12	NA	NA	9	13
SD:	NA	0.7	0.7	NA	NA	0.5	NA	NA	1.2	0.5
124. As an aid in finding things, was the table of contents helpful?										
M:	2.2	2.9	1.7	2.0	2.3	1.8	NA	2.7	3.1	2.4
N:	10	9	11	11	10	12	NA	11	11	12
SD:	1.0	1.1	0.6	0.6	0.9	0.8	NA	0.8	1.1	1.1
125. As an aid in finding things, was the index helpful?										
M:	NA	NA	2.0	NA	NA	2.6	NA	NA	3.0	2.4
N:	NA	NA	12	NA	NA	11	NA	NA	8	12
SD:	NA	NA	0.7	NA	NA	1.0	NA	NA	1.3	1.2
126. Were the sequences of functions needed to properly operate the radio clearly indicated?										
M:	1.7	2.1	1.8	1.7	1.8	1.8	NA	1.7	2.3	1.3
N:	12	10	12	12	12	12	NA	12	12	12
SD:	0.9	0.7	0.4	0.5	0.8	0.6	NA	0.5	0.9	0.4
127. Were possible safety hazards or dangers in using the radio well indicated?										
M:	3.0	2.7	1.8	1.7	1.8	2.0	NA	2.1	2.8	1.6
N:	12	10	12	12	12	12	NA	12	12	13
SD:	0.8	1.0	0.7	0.6	0.6	0.7	NA	0.6	1.0	0.6
128. Was the information on PMCS (Preventive Maintenance, Checks, and Services) clear?										
M:	3.3	2.7	1.8	2.0	2.3	2.0	NA	2.0	3.1	1.8
N:	12	10	12	10	11	12	NA	12	11	13
SD:	0.9	1.1	0.4	0.8	1.0	0.6	NA	0.0	0.7	0.6

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Table 3.9, continued

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR MANUALS

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
129. Was the explanation of individual maintenance clear?										
M:	3.2	2.4	1.8	2.0	2.4	1.9	NA	1.9	2.8	2.0
N:	12	10	12	10	12	12	NA	12	12	13
SD:	1.0	0.8	0.4	0.5	0.9	0.5	NA	0.5	1.2	0.7
130. Overall, how helpful was the manual in learning about the radio?										
M:	3.2	2.5	1.9	2.2	1.9	2.3	NA	2.5	3.3	1.8
N:	12	10	12	11	12	12	NA	12	12	13
SD:	1.3	0.8	0.6	1.0	0.8	1.2	NA	0.7	1.0	0.8

Note: The following question was based on a 7-point scale ranging from "a" (most favorable) to "g" (least favorable), where "a" = 1 and "g" = 7.

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
131. Overall, how would you rate the quality of the operator's manual?										
M:	3.7	3.1	2.4	2.4	2.6	2.2	NA	3.0	3.9	2.5
N:	12	10	12	12	12	11	NA	12	12	13
SD:	1.2	0.8	0.6	0.5	1.0	0.8	NA	0.8	0.9	0.8

Table 3.10

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR TRAINING

> Note: Unless indicated by asterisks (*), the means below are based on scales ranging from "a" (most favorable) to "e" (least favorable), where "a" = 1 and "e" = 5. Means with asterisks are based on bipolar scales in which the center of the scale ("c") was the most favorable response, while "a" and "e" were the least favorable responses.

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
132. The one-week training period was:										
M:	2.6*	1.8*	3.0*	2.3*	2.8*	2.0*	2.4*	2.5*	3.1*	2.3*
N:	12	12	12	12	12	12	13	12	12	13
SD:	1.3	0.7	0.6	0.6	0.6	0.6	0.6	1.0	0.5	0.6
133. The class instruction was:										
M:	1.7	1.5	2.1	1.2	1.0	1.5	1.3	1.8	1.3	1.1
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.6	0.7	0.6	0.4	0.0	0.7	0.6	0.8	0.7	0.3
134. Should the training course be made easier or harder for soldiers who may operate the radio in the future?										
M:	3.3*	3.1*	3.2*	2.8*	3.0*	2.6*	2.9*	3.4*	2.8*	3.0*
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.6	0.3	0.6	0.7	0.4	0.8	0.3	0.5	0.6	0.4
135. The time spent on "hands-on" (practical) exercises was:										
M:	2.7*	2.7*	3.2*	2.5*	3.1*	2.5*	2.9*	3.0*	2.9*	2.9*
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.5	0.9	0.4	0.8	0.3	0.8	0.3	0.7	0.6	0.3

[Continued on next page]

*See note at beginning of table.

Table 3.10, continued

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR TRAINING

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
136. The number of "hands on" (practical) exercises was:										
M:	2.7*	3.1*	3.3*	2.8*	3.0*	2.7*	2.9*	2.9*	2.9*	2.9*
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.5	0.3	0.4	0.7	0.4	0.6	0.4	0.3	0.6	0.3
137. The "hands on" (practical) exercises in class were:										
M:	1.2	1.5	1.4	1.1	1.0	1.3	1.2	1.4	1.2	1.2
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.6	0.8	0.6	0.3	0.0	0.6	0.4	0.8	0.3	0.4
138. The opportunity to ask questions was:										
M:	1.3	1.4	1.5	1.0	1.1	1.1	1.2	1.1	1.1	1.1
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.5	0.6	0.5	0.0	0.3	0.3	0.4	0.3	0.4	0.3
139. Were answers to students' questions helpful?										
M:	1.5	1.5	1.6	1.1	1.1	1.0	1.2	1.3	1.2	1.1
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.5	0.5	0.6	0.3	0.3	0.0	0.4	0.5	0.4	0.3
140. The units of instruction were:										
M:	2.5*	2.3*	2.8*	2.7*	2.8*	2.2*	3.0*	2.9*	2.8*	2.9*
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.7	0.9	0.4	0.6	0.4	0.9	0.4	0.5	0.4	0.5
141. The pace of the class (training) was:										
M:	3.4*	3.5*	3.3*	3.4*	3.1*	3.7*	1.8*	3.1*	3.0*	3.2*
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.6	0.8	0.6	0.6	0.5	0.8	0.4	0.0	0.7	0.4

[Continued on next page]

*See note at beginning of table.

Table 3.10, continued

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR TRAINING

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
142. The language level of the instruction was:										
M:	2.9*	3.1	3.1*	3.0*	2.9*	3.2*	1.9*	3.0*	3.0*	3.0*
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.3	0.3	0.3	0.0	0.3	0.4	0.0	0.0	0.0	0.0
143. The interest level of the course content was:										
M:	1.6	2.5	2.4	1.4	1.4	2.3	1.5	1.6	1.8	1.5
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.9	0.9	0.8	0.5	0.5	1.2	0.8	0.6	1.1	0.5
144. The audio-visual aids (overhead slides, pictures, chart boards, etc.) were:										
M:	2.0	2.8	2.4	1.8	1.5	1.9	1.9	1.8	2.1	1.9
N:	12	10	12	12	12	12	13	12	11	13
SD:	1.1	1.3	0.8	0.9	0.5	0.6	1.2	0.7	0.9	0.7
145. The number of radios used in training was:										
M:	1.6	1.5	1.9	1.8	1.5	2.2	1.5	1.8	3.8	1.9
N:	12	12	12	12	12	12	13	12	12	13
SD:	0.5	0.5	0.5	0.8	0.5	0.7	0.5	0.6	0.4	0.4
146. The operator manuals for the radio were used:										
M:	3.4	3.4	2.3	3.3	3.3	2.9	5.0	3.2	3.8	2.9
N:	12	10	12	12	12	12	5	12	12	13
SD:	1.1	1.1	0.9	1.3	0.9	1.2	0.0	0.7	0.9	0.9
147. The operator manuals used in training were:										
M:	3.0	3.0	1.8	1.9	2.1	2.4	NA	2.5	3.5	2.2
N:	12	10	12	12	12	12	NA	12	12	13
SD:	1.0	0.8	0.6	0.5	1.1	1.1	NA	1.0	1.1	1.1

[Continued on next page]

*See note at beginning of table.

Table 3.10, continued

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR TRAINING

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
148. The short "in-the-field" exercise you had with the radio was:										
M:	2.3	3.5	2.6	1.6	2.9	1.9	NA	2.0	3.2	NA
N:	12	10	12	10	10	12	NA	10	9	NA
SD:	1.1	1.0	1.0	0.5	1.0	0.6	NA	0.6	0.9	NA
149. Has the training adequately prepared all the students in your class to operate this radio in the field?										
M:	1.6	1.7	2.1	1.3	1.8	1.4	1.6	1.5	1.8	1.3
N:	12	12	12	12	12	12	12	11	11	13
SD:	0.5	0.8	0.5	0.9	0.6	0.6	0.6	0.5	0.8	0.6

> Note: The following question was based on a 7-point scale ranging from "a" (most favorable) to "g" (least favorable), where "a" = 1 and "g" = 7.

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
150. On an overall basis, rate the radio operator training you received in this class.										
M:	2.1	1.7	2.6	1.3	1.6	1.5	1.5	1.8	1.8	1.4
N:	12	12	12	12	12	12	13	11	12	13
SD:	0.8	0.8	0.8	0.6	0.6	0.5	0.6	0.7	0.8	0.6

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Table 3.10, continued

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR TRAINING

> Note. Questions 151-160 were preceded by the following general question:
>
> "Which of the following changes, if any, could be made to improve this training course for future students?"
>
> The data are frequencies.

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
151. Course length.										
N:	12	12	12	12	12	12	13	11	12	13
Increase:	1	0	0	0	2	0	0	2	4	0
Decrease:	6	10	2	6	3	8	1	6	1	5
No change:	5	2	10	6	7	4	12	3	7	8
152. Content level.										
N:	12	12	12	12	12	12	13	11	12	13
Increase:	3	3	2	4	3	2	0	3	5	3
Decrease:	0	0	0	0	0	0	0	0	0	0
No change:	9	9	10	8	9	10	13	8	7	10
153. Practical exercises.										
N:	12	12	12	12	12	12	13	11	12	13
Increase:	1	1	5	2	7	1	2	2	4	1
Decrease:	2	0	0	0	0	1	0	1	0	0
No change:	9	11	7	10	5	10	11	8	8	12

[Continued on next page]

Table 3.10, continued

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR TRAINING

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
154. Pace of instruction.										
N:	12	12	12	12	12	12	13	11	12	13
Increase:	3	6	5	2	3	3	1	4	2	3
Decrease:	0	0	0	2	0	0	0	0	1	0
No change:	9	6	7	8	9	9	12	7	9	10
155. Language level.										
N:	12	12	12	12	12	12	13	11	12	13
Increase:	0	2	1	0	0	2	0	0	0	0
Decrease:	0	0	0	0	0	0	0	0	0	0
No change:	12	10	11	12	12	10	13	11	12	13
156. "Hands on" time.										
N:	12	12	12	12	12	12	13	11	12	13
Increase:	0	2	5	1	6	3	1	2	2	0
Decrease:	3	0	0	4	0	3	0	0	1	0
No change:	9	10	7	7	6	6	12	9	9	13
157. Audio-visual aids.										
N:	12	12	12	12	12	12	13	11	10	13
Increase:	4	4	1	3	3	3	0	6	5	2
Decrease:	1	1	3	0	0	1	0	0	0	0
No change:	7	7	8	9	9	8	13	5	5	11
158. Reviews.										
N:	12	12	12	12	12	12	13	11	12	13
Increase:	01	4	3	5	1	2	0	3	0	0
Decrease:	0	0	2	1	1	0	0	0	2	0
No change:	11	8	7	6	10	10	13	8	10	13
159. Use of manuals.										
N:	12	11	12	12	11	12	NA	11	12	13
Increase:	6	4	1	3	7	2	NA	3	4	1
Decrease:	0	1	0	0	0	3	NA	1	3	0
No change:	6	6	11	9	4	7	NA	7	5	12

[Continued on next page]

Table 3.10, continued

Post-Training MANPRINT Evaluation Questionnaire Results: OPERATOR TRAINING

Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
160. Class field exercise.										
N:	12	11	12	10	11	11	NA	11	11	NA
Increase:	0	3	3	1	6	2	NA	2	2	NA
Decrease:	1	0	1	1	0	2	NA	1	5	NA
No change:	11	8	8	8	5	7	NA	8	4	NA

Table 4

Comparison of Radios by Content Area and Vendor
(Post-Training MANPRINT Evaluation Questionnaire)

Content Area		ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
Display	R:	6.5	8.5	3.5	1	2	3.5	5	8.5	10	6.5
	M:	+2.2	+2.3	+1.9	+1.7	+1.8	+1.9	+2.1	+2.3	+2.6	+2.2
	SD:	0.6	0.6	0.5	0.4	0.5	0.5	0.5	0.7	0.7	0.7
	N:	12	12	12	12	12	12	13	12	12	13
Control Knobs	R:	4.5	10	4.5	1.5	1.5	3	7	8	9	6
	M:	+2.2	+2.8	+2.2	+2.0	+2.0	+2.1	+2.4	+2.5	+2.6	+2.3
	SD:	0.6	0.7	0.6	0.5	0.6	0.7	0.8	0.9	0.9	0.7
	N:	12	12	12	10	12	12	13	10	12	13
Toggle and/or Button Switches	R:	NA	4.5	NA	1	NA	NA	NA	3	4.5	2
	M:	NA	+2.5	NA	+1.7	NA	NA	NA	+2.2	+2.5	+2.0
	SD:	NA	0.9	NA	0.6	NA	NA	NA	0.9	0.5	0.8
	N:	NA	12	NA	12	NA	NA	NA	11	03	13
Keyboard (Keypad)[a]	R:	4	NA	1.5	NA	1.5	NA	NA	4	4	NA
	M:	+2.1	NA	+1.8	NA	+1.8	NA	NA	+2.1	+2.1	NA
	SD:	0.8	NA	0.5	NA	0.6	NA	NA	0.6	0.8	NA
	N:	12	NA	12	NA	12	NA	NA	12	12	NA
Connector Plugs and Sockets	R:	7	6	8	1	4.5	3	2	10	9	4.5
	M:	+2.4	+2.3	+2.5	+1.8	+2.2	+2.1	+1.9	+2.9	+2.8	+2.2
	SD:	0.6	0.8	0.8	0.7	0.7	0.8	0.8	1.0	0.9	0.7
	N:	12	12	12	12	12	12	12	12	12	13
Procedures	R:	6.5	2.5	8.5	1	4.5	6.5	2.5	8.5	10	4.5
	M:	+1.8	+1.6	+1.9	+1.3	+1.7	+1.8	+1.6	+1.9	+2.0	+1.7
	SD:	0.6	0.5	0.5	0.4	0.6	0.5	0.7	0.6	0.6	0.7
	N:	12	12	12	12	12	12	13	12	12	13
Audio Tasks	R:	7.5	7.5	7.5	2	4.5	10	1	3	7.5	4.5
	M:	+2.0	+2.0	+2.0	+1.6	+1.8	+2.2	+1.4	+1.7	+2.0	+1.8
	SD:	0.6	0.9	0.5	0.6	0.5	0.8	0.6	0.8	0.7	0.7
	N:	12	12	12	12	12	12	13	12	12	13
Visual Tasks	R:	6.5	3	1	5	6.5	3	3	9	10	8
	M:	+1.8	+1.6	+1.5	+1.7	+1.8	+1.6	+1.6	+2.0	+2.2	+1.9
	SD:	0.6	0.5	0.5	0.7	0.4	0.8	0.5	0.8	0.8	1.0
	N:	12	12	12	12	12	12	13	12	12	12

[a]Three of the 10 questionnaire items upon which the data in this section are based used 5- rather than 7-point scales. For computational convenience, the 3 items were mathematically converted according to the formula $Y = 1.5X - .5$, where Y and X refer to the 7- and 5-point scales, respectively.

Table 5

Summary Comparisons of Radios, Operator's Manuals, and Training Courses (Post-Training MANPRINT Evaluation Questionnaire)

Topic		ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
Radios	R:	6.5	8.5	4.5	1	2.5	4.5	2.5	8.5	10	6.5
	M:	+2.1	+2.2	+2.0	+1.6	+1.9	+2.0	+1.9	+2.2	+2.4	+2.1
	SD:	0.4	0.5	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.6
	N:	12	12	12	12	12	12	13	12	12	13
Operator Manual[a]	R:	9	7	2	4	5	2	NA	6	8	2
	M:	2.8*	2.3*	1.8*	1.9*	2.0*	1.8*	NA	2.2*	2.7*	1.8*
	SD:	0.7	0.3	0.2	0.4	0.5	0.3	NA	0.3	0.7	0.4
	N:	12	10	12	12	12	12	NA	12	12	13
Operator Training[a]	R:	8.5	8.5	6	4.5	3	8.5	1	4.5	8.5	2
	M:	1.8*	1.8*	1.7*	1.6*	1.5*	1.8*	1.3*	1.6*	1.8*	1.4*
	SD:	0.3	0.2	0.3	0.3	0.2	0.4	0.2	0.3	0.3	0.3
	N:	12	12	12	12	12	12	13	12	12	13

[a]Means with asterisks are based on items that used five-point scales, where 1 = most favorable and 5 = least favorable.

Table 6

MANPRINT Team Evaluation of Operator Manuals

Radio	Scale Value[a]				Mean Scale Value[b]	Rank
	Content	Readability	Illustration	Durability		
HAR	-6	+71	+88	+100	+51	1
MAR	+31	+50	+50	+50	+43	2
THO	+29	+71	+75	-50	+35	3
ROC	-19	+36	+25	+50	+17	4
ITT	+38	+15	+38	-50	+16	5
TWC	+26	0	+13	-100	-7	6
SEL	+7	+7	-29	-100	-19	7
TAD	+25	-36	-13	-100	-22	8
RAC	-19	-36	-38	0	-24	9
ERI	-75	+8	-100	-100	-62	10

[a]Scale: -100 (poor) to +100 (good).
[b]Computed on weighted scale values: Content = 1.00; Readability = .75; Illustration = .50; Durability = .50.

Table 7.1

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
COMMUNICATION PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
001.	Static or electronic interference from M113 engine?										
	Freq. Cited:	2	1	1	0	2	1	0	1	3	0
	Fix Priority:	2.5	1.0	2.0	NA	3.0	3.0	NA	--	3.0	NA
002.	Static or electronic interference from M151 engine?										
	Freq. Cited:	0	2	2	1	0	0	0	0	0	1
	Fix Priority:	NA	3.0	2.5	3.0	NA	NA	NA	NA	NA	3.0
003.	Static or electronic interference from M577 engine?										
	Freq. Cited:	0	2	0	0	0	0	0	0	0	0
	Fix Priority:	NA	3.0	NA	NA	NA	NA	NA	NA	NA	NA
004.	Static or electronic interference from M60A1 engine?										
	Freq. Cited:	2	2	3	2	1	4	0	0	0	0
	Fix Priority:	2.0	3.0	2.3	3.0	1.0	2.8	NA	NA	NA	NA
005.	Other static problems?										
	Freq. Cited:	3	6	8	5	6	6	0	2	5	3
	Fix Priority:	2.7	2.3	2.4	2.4	1.4	2.3	NA	2.5	1.6	2.0
006.	Bad weather produced poor communications?										
	Freq. Cited:	3	2	7	1	3	1	2	1	10	0
	Fix Priority:	2.0	2.0	2.2	3.0	1.5	--	1.0	3.0	2.1	NA
007.	Radio interferes with intercom?										
	Freq. Cited:	1	3	0	2	1	3	1	0	2	0
	Fix Priority:	2.0	2.7	NA	2.0	3.0	2.3	3.0	NA	2.0	NA
008.	Background noise made it hard to hear in handset?										
	Freq. Cited:	6	4	5	3	5	6	3	3	4	1
	Fix Priority:	2.2	2.5	2.2	2.7	1.8	2.4	2.5	2.0	2.8	--

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Table 7.1, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
COMMUNICATION PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
009.	Background noise made it hard to hear speaker?										
	Freq. Cited:	2	3	4	1	1	5	0	4	5	2
	Fix Priority:	2.5	1.7	2.3	3.0	1.0	2.0	NA	2.0	2.8	--
010.	Loss of communication using VINSON (KY-57)?										
	Freq. Cited:	0	10	9	5	10	6	0	0	3	5
	Fix Priority:	NA	3.0	2.7	3.0	2.3	2.8	NA	NA	3.0	2.0
011.	Any volume problems when using VINSON (KY-57)?										
	Freq. Cited:	0	7	4	3	5	1	0	0	2	2
	Fix Priority:	NA	2.9	2.5	2.7	2.0	2.0	NA	NA	2.5	2.0
012.	Static or poor sound quality with VINSON (KY-57)										
	Freq. Cited:	0	11	6	4	6	7	0	0	2	2
	Fix Priority:	NA	2.5	2.5	3.0	2.2	2.1	NA	NA	3.0	2.5
013.	Static or poor sound quality with remote hookup?										
	Freq. Cited:	0	2	0	1	4	1	0	0	1	0
	Fix Priority:	NA	1.0	NA	2.0	1.5	1.0	NA	NA	3.0	NA
014.	Problem understanding voice communication in frequency-hopping mode?										
	Freq. Cited:	2	0	7	4	1	6	0	1	3	0
	Fix Priority:	2.0	NA	2.3	3.0	1.0	1.8	NA	2.0	2.0	NA
015.	Problem understanding voice communication in single (fixed) frequency mode?										
	Freq. Cited:	0	0	0	1	0	1	0	0	2	0
	Fix Priority:	NA	NA	NA	3.0	NA	1.0	NA	NA	3.0	NA
016.	Quality of sound is bad (but not due to static)?										
	Freq. Cited:	0	1	1	0	2	2	0	0	1	0
	Fix Priority:	NA	3.0	1.0	NA	2.0	2.0	NA	NA	3.0	NA

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Table 7.1, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results: COMMUNICATION PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
017.	Problem sending a CUE call (page/rescue/clear net)?										
	Freq. Cited:	0	0	0	0	2	1	0	4	6	0
	Fix Priority:	NA	NA	NA	NA	1.5	2.0	NA	1.7	2.3	NA
018.	Failure to hear or see a CUE (page/rescue/clear net)?										
	Freq. Cited:	0	1	1	0	1	1	0	2	2	0
	Fix Priority:	NA	3.0	3.0	NA	3.0	3.0	NA	1.0	1.0	NA
019.	Problem with a whisper mode?										
	Freq. Cited:	0	0	0	0	0	0	0	0	0	0
	Fix Priority:	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
020.	Accidental or unexplained loss of information loaded into the radio (frequencies, time, etc.)?										
	Freq. Cited:	2	1	6	1	0	2	0	0	0	3
	Fix Priority:	1.5	3.0	3.0	3.0	NA	1.5	NA	NA	NA	1.3
021.	Hard to hear or understand communication while wearing MOPP (NBC) gear?										
	Freq. Cited:	0	1	0	1	0	0	0	0	0	0
	Fix Priority:	NA	--	NA	2.0	NA	NA	NA	NA	NA	NA
022.	Radio forgets stored information when it is turned off?										
	Freq. Cited:	0	0	0	0	0	0	0	0	0	0
	Fix Priority:	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
023.	Received false CUE (page/rescue/clear net) signals?										
	Freq. Cited:	1	2	2	1	3	2	0	2	3	0
	Fix Priority:	1.0	2.5	2.5	3.0	2.0	2.0	NA	2.0	2.5	NA
024.	Poor voice-transmission quality while frequency hopping?										
	Freq. Cited:	4	1	5	3	1	7	0	1	2	0
	Fix Priority:	3.0	3.0	2.2	3.0	--	1.9	NA	3.0	2.5	NA

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Table 7.1, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
COMMUNICATION PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
025. Poor voice-transmission quality while on a single (fixed) frequency?											
	Freq. Cited:	0	0	0	1	1	0	0	0	2	0
	Fix Priority:	NA	NA	NA	3.0	--	NA	NA	NA	3.0	NA
026. Problem sending data in non-secure (clear/plain) mode?											
	Freq. Cited:	2	0	3	1	0	2	1	0	2	2
	Fix Priority:	2.0	NA	3.0	3.0	NA	1.5	1.0	NA	3.0	3.0
027. Problem sending data in frequency-hopping mode?											
	Freq. Cited:	4	0	4	4	3	5	3	0	4	0
	Fix Priority:	2.0	NA	2.8	3.0	2.0	2.3	2.3	NA	2.5	NA
028. Problem transmitting with power amplifier?											
	Freq. Cited:	1	0	1	1	0	1	0	0	0	3
	Fix Priority:	3.0	NA	3.0	1.0	NA	2.0	NA	NA	NA	3.0

Table 7.2

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
KEYPAD (KEYBOARD) PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
029.	Poor location?										
	Freq. Cited:	0	0	0	0	0	0	0	0	0	0
	Fix Priority:	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
030.	Have to push keys too hard?										
	Freq. Cited:	4	0	0	0	0	0	0	2	5	0
	Fix Priority:	2.3	NA	NA	NA	NA	NA	NA	3.0	2.0	NA
031.	Keys push too easily?										
	Freq. Cited:	0	0	0	0	0	0	0	0	0	0
	Fix Priority:	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
032.	Keys sometimes don't work right?										
	Freq. Cited:	3	0	1	0	0	0	0	1	5	0
	Fix Priority:	2.3	NA	2.0	NA	NA	NA	NA	--	2.4	NA
033.	Keys hard to read in low light?										
	Freq. Cited:	7	0	8	0	7	0	0	4	4	0
	Fix Priority:	2.6	NA	2.0	NA	2.0	NA	NA	2.5	2.0	NA
034.	Abbreviations on keys, if any are hard to understand?										
	Freq. Cited:	2	0	0	0	0	0	0	1	0	0
	Fix Priority:	1.0	NA	NA	NA	NA	NA	NA	2.0	NA	NA
035.	Some keys do things that are not labeled on them?										
	Freq. Cited:	3	0	1	1	8	0	0	4	0	0
	Fix Priority:	1.0	NA	1.0	2.0	2.0	NA	NA	2.3	NA	NA
036.	Keypad too small?										
	Freq. Cited:	1	0	1	0	0	0	0	0	2	0
	Fix Priority:	--	NA	--	NA	NA	NA	NA	NA	1.5	NA

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Table 7.2, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
KEYPAD (KEYBOARD) PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
037.	Keys are prone to damage or wear?										
	Freq. Cited:	3	0	3	1	5	0	0	1	2	0
	Fix Priority:	1.7	NA	2.0	2.0	1.6	NA	NA	3.0	2.0	NA
038.	Keys too close together for fingers?										
	Freq. Cited:	1	0	0	0	0	0	0	0	3	0
	Fix Priority:	--	NA	NA	NA	NA	NA	NA	NA	2.5	NA
039.	Can't feel when key has been pressed?										
	Freq. Cited:	3	0	0	1	0	0	0	1	3	0
	Fix Priority:	2.5	NA	NA	3.0	NA	NA	NA	--	3.0	NA
040.	Keys don't have a good "feel"?										
	Freq. Cited:	3	0	0	1	0	0	0	0	3	0
	Fix Priority:	1.5	NA	NA	3.0	NA	NA	NA	NA	3.0	NA
041.	Keys too close together for operation while wearing MOPP (NBC) gloves?										
	Freq. Cited:	4	0	0	0	2	0	0	2	2	0
	Fix Priority:	2.0	NA	NA	NA	2.0	NA	NA	2.5	1.5	NA

Table 7.3

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results: DISPLAY PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
042. Poor location of display window?											
	Freq. Cited:	1	2	0	0	0	1	0	2	0	0
	Fix Priority:	3.0	3.0	NA	NA	NA	3.0	NA	2.0	NA	NA
043. Not bright enough?											
	Freq. Cited:	1	0	0	1	2	3	0	6	2	0
	Fix Priority:	--	NA	NA	3.0	2.5	3.0	NA	2.2	1.0	NA
044. Not dim enough?											
	Freq. Cited:	1	0	0	1	0	0	0	0	3	0
	Fix Priority:	--	NA	NA	3.0	NA	NA	NA	NA	1.0	NA
045. Poor brightness adjustment?											
	Freq. Cited:	1	0	0	0	3	2	0	2	0	1
	Fix Priority:	2.0	NA	NA	NA	2.0	3.0	NA	1.5	NA	3.0
046. Bad reflections (glare)?											
	Freq. Cited:	4	1	1	0	1	8	0	2	2	2
	Fix Priority:	2.3	1.0	2.0	NA	1.0	2.3	NA	2.0	1.5	2.0
047. Display flickers?											
	Freq. Cited:	0	0	2	0	1	1	0	0	1	1
	Fix Priority:	NA	NA	2.0	NA	--	2.0	NA	NA	2.0	1.0
048. Poor readability under normal lighting conditions?											
	Freq. Cited:	1	1	1	0	0	2	0	2	1	1
	Fix Priority:	3.0	1.0	3.0	NA	NA	3.0	NA	2.5	3.0	3.0
049. Hard to read display in direct sunlight?											
	Freq. Cited:	9	3	2	1	2	6	2	6	2	4
	Fix Priority:	1.9	2.3	2.5	2.0	1.0	2.6	1.0	2.2	2.0	2.0

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Table 7.3, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
DISPLAY PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
050. Hard to read in low light?											
	Freq. Cited:	2	0	1	1	2	8	0	3	2	2
	Fix Priority:	2.5	NA	2.0	1.0	2.0	2.6	NA	2.3	2.0	2.0
051. Display difficult to light up?											
	Freq. Cited:	1	0	0	0	1	2	0	2	0	2
	Fix Priority:	2.0	NA	NA	NA	2.0	3.0	NA	2.5	NA	3.0
052. Letters and numbers unnecessarily large?											
	Freq. Cited:	0	0	0	0	0	0	1	0	0	0
	Fix Priority:	NA	NA	NA	NA	NA	NA	1.0	NA	NA	NA
053. Letters and numbers too small?											
	Freq. Cited:	0	0	0	0	0	2	0	5	0	1
	Fix Priority:	NA	NA	NA	NA	NA	1.5	NA	2.0	NA	--
054. Display light does not stay on long enough?											
	Freq. Cited:	2	7	3	2	1	6	1	3	2	5
	Fix Priority:	2.5	1.6	1.7	2.0	2.0	2.5	3.0	2.0	1.0	2.3
055. Display light stays on too long?											
	Freq. Cited:	3	1	0	0	0	1	0	1	0	0
	Fix Priority:	2.0	--	NA	NA	NA	3.0	NA	1.0	NA	NA
056. Hard to read display from your normal operating position?											
	Freq. Cited:	0	3	3	2	1	5	0	4	3	1
	Fix Priority:	NA	3.0	2.3	2.0	1.0	2.8	NA	2.3	1.7	3.0
057. Poor readability from different angles?											
	Freq. Cited:	7	7	3	3	2	7	3	7	8	4
	Fix Priority:	1.8	2.3	1.7	2.0	1.5	2.6	2.0	2.0	2.1	2.0

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Table 7.3, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
DISPLAY PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
058. Poor readability from 6-foot distance?											
	Freq. Cited:	4	0	0	2	2	5	1	8	4	2
	Fix Priority:	1.5	NA	NA	1.5	2.0	3.0	2.0	2.0	2.0	1.0
059. Numbers or letters on display look strange?											
	Freq. Cited:	0	0	1	1	1	1	1	0	1	0
	Fix Priority:	NA	NA	1.0	2.0	--	3.0	3.0	NA	1.0	NA
060. Some letters and numbers look alike?											
	Freq. Cited:	0	1	2	6	4	1	0	1	2	1
	Fix Priority:	NA	--	2.0	2.0	1.7	3.0	NA	2.0	2.0	--
061. Confuse one letter or number with another?											
	Freq. Cited:	0	1	1	3	2	2	0	0	2	0
	Fix Priority:	NA	--	2.0	2.3	2.0	2.5	NA	NA	2.0	NA
062. Abbreviations used in display not meaningful?											
	Freq. Cited:	0	1	2	2	0	1	1	2	0	1
	Fix Priority:	NA	1.0	1.5	2.5	NA	3.0	3.0	1.0	NA	--
063. Capital and small letters mixed together in uncommon way?											
	Freq. Cited:	0	0	3	0	0	1	0	0	0	0
	Fix Priority:	NA	NA	2.7	NA	NA	3.0	NA	NA	NA	NA
064. Poor choice of words or symbols used in display?											
	Freq. Cited:	0	1	0	0	1	1	1	0	0	0
	Fix Priority:	NA	1.0	NA	NA	1.0	3.0	3.0	NA	NA	NA
065. Display is too complicated?											
	Freq. Cited:	0	0	0	0	0	1	0	0	1	0
	Fix Priority:	NA	NA	NA	NA	NA	3.0	NA	NA	2.0	NA

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Table 7.3, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
DISPLAY PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
066. Misread display for any reason?											
	Freq. Cited:	0	2	0	0	1	1	0	2	0	1
	Fix Priority:	NA	1.0	NA	NA	1.0	3.0	NA	1.0	NA	3.0
067. Display shows wrong information?											
	Freq. Cited:	1	1	0	0	1	1	0	0	0	0
	Fix Priority:	2.0	3.0	NA	NA	1.0	3.0	NA	NA	NA	NA
068. Display information hard to understand?											
	Freq. Cited:	0	2	0	0	1	1	0	0	1	0
	Fix Priority:	NA	1.0	NA	NA	1.0	3.0	NA	NA	2.0	NA
069. Not enough feedback?											
	Freq. Cited:	1	1	2	1	0	1	0	1	2	1
	Fix Priority:	2.0	--	2.0	3.0	NA	3.0	NA	--	2.0	--
070. Not enough reminders?											
	Freq. Cited:	2	1	3	1	0	1	0	1	1	1
	Fix Priority:	2.0	--	2.3	--	NA	3.0	NA	--	2.0	--
071. Display responds too slowly?											
	Freq. Cited:	1	1	2	0	0	2	0	0	0	0
	Fix Priority:	1.0	--	1.0	NA	NA	3.0	NA	NA	NA	NA
072. Display shows nothing when some keys on keypad are pressed?											
	Freq. Cited:	2	2	2	1	1	1	0	1	2	0
	Fix Priority:	1.0	1.5	1.0	3.0	--	3.0	NA	2.0	1.5	NA
073. Display does not indicate when your input has been accepted?											
	Freq. Cited:	0	2	0	2	2	2	0	1	2	0
	Fix Priority:	NA	2.0	NA	3.0	1.0	1.5	NA	3.0	2.0	NA

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Table 7.3, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
DISPLAY PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
074. Hard to read or see while in MOPP (NBC) gear?											
	Freq. Cited:	0	0	0	1	0	1	0	0	0	0
	Fix Priority:	NA	NA	NA	2.0	NA	3.0	NA	NA	NA	NA
075. Display window prone to damage (scratching, etc.)?											
	Freq. Cited:	2	1	2	1	7	2	1	1	5	3
	Fix Priority:	1.5	1.0	1.5	3.0	1.8	2.5	1.0	3.0	2.0	1.3

Table 7.4

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results: PROBLEMS WITH TOGGLE AND/OR BUTTON SWITCHES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
076.	Inconvenient location?										
	Freq. Cited:	0	1	3	2	2	1	2	2	2	1
	Fix Priority:	NA	--	2.5	2.0	2.0	1.0	2.5	2.5	3.0	--
077.	Too crowded (too close to other controls)?										
	Freq. Cited:	0	2	5	3	4	2	5	4	2	2
	Fix Priority:	NA	2.0	2.7	3.0	2.0	2.0	1.8	2.0	3.0	2.0
078.	Too small?										
	Freq. Cited:	0	3	0	0	0	1	5	1	1	0
	Fix Priority:	NA	2.0	NA	NA	NA	2.0	1.5	2.0	--	NA
079.	Too large?										
	Freq. Cited:	0	1	0	1	0	1	2	0	0	0
	Fix Priority:	NA	3.0	NA	3.0	NA	1.0	1.0	NA	NA	NA
080.	Unsturdy (prone to damage)?										
	Freq. Cited:	2	7	2	2	2	1	0	0	1	0
	Fix Priority:	2.0	2.0	2.0	2.5	1.5	1.0	NA	NA	2.0	NA
081.	A toggle or button switch broke?										
	Freq. Cited:	1	2	0	0	0	0	0	0	0	0
	Fix Priority:	2.0	2.5	NA	NA	NA	NA	NA	NA	NA	NA
082.	Easy to switch accidentally?										
	Freq. Cited:	3	2	1	4	1	3	0	1	2	6
	Fix Priority:	2.0	2.0	3.0	2.0	1.0	1.3	NA	--	2.0	2.0
083.	Poor "feel" (snap, click)?										
	Freq. Cited:	1	3	0	1	1	1	0	0	2	1
	Fix Priority:	2.0	2.0	NA	--	1.0	2.0	NA	NA	2.0	3.0

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Table 7.4, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results: PROBLEMS WITH TOGGLE AND/OR BUTTON SWITCHES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
084. Hard to operate?											
	Freq. Cited:	0	0	1	0	0	0	3	0	1	0
	Fix Priority:	NA	NA	2.0	NA	NA	NA	2.0	NA	2.0	NA
085. Button or switch hurts finger?											
	Freq. Cited:	0	0	2	0	1	2	3	1	0	0
	Fix Priority:	NA	NA	2.0	NA	--	2.5	2.5	3.0	NA	NA

Table 7.5

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH CONTROL KNOBS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
086.	Poor arrangement of knobs on front panel?										
	Freq. Cited:	0	1	1	1	4	0	2	1	1	1
	Fix Priority:	NA	--	--	3.0	2.0	NA	2.0	--	2.0	--
087.	Color of controls does not contrast with color of front panel?										
	Freq. Cited:	0	2	1	1	3	2	1	3	1	1
	Fix Priority:	NA	2.0	--	1.0	1.0	1.0	1.0	2.0	1.0	--
088.	Knobs too crowded (too close to each other or to other controls?										
	Freq. Cited:	1	1	6	3	7	2	8	2	2	2
	Fix Priority:	1.0	2.0	1.7	3.0	2.2	2.0	1.9	2.5	2.5	2.0
089.	Too many knobs or switches needed to perform single function?										
	Freq. Cited:	0	2	1	1	1	1	1	0	1	1
	Fix Priority:	NA	2.0	1.0	3.0	1.0	1.0	2.0	NA	1.0	3.0
090.	Too large?										
	Freq. Cited:	0	0	0	0	0	0	1	0	0	0
	Fix Priority:	NA	NA	NA	NA	NA	NA	2.0	NA	NA	NA
091.	Too small?										
	Freq. Cited:	1	2	0	0	0	2	4	0	2	0
	Fix Priority:	3.0	2.0	NA	NA	NA	1.5	1.5	NA	2.0	NA
092.	Not shaped right for good grasp?										
	Freq. Cited:	1	1	0	1	1	3	2	3	3	1
	Fix Priority:	--	1.0	NA	--	1.0	2.0	3.0	2.5	2.5	--
093.	Not strong enough?										
	Freq. Cited:	2	3	0	0	2	0	1	1	4	1
	Fix Priority:	2.5	2.3	NA	NA	3.0	NA	--	--	1.3	--

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Table 7.5, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH CONTROL KNOBS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
094.	A knob broke?										
	Freq. Cited:	1	0	0	0	0	1	0	0	0	0
	Fix Priority:	2.0	NA	NA	NA	NA	3.0	NA	NA	NA	NA
095.	Did not work right?										
	Freq. Cited:	1	1	0	0	1	0	0	0	1	0
	Fix Priority:	3.0	2.0	NA	NA	--	NA	NA	NA	--	NA
096.	Too hard to turn?										
	Freq. Cited:	0	1	0	1	0	1	5	2	1	0
	Fix Priority:	NA	--	NA	1.0	NA	3.0	2.0	3.0	3.0	NA
097.	Too easy to turn?										
	Freq. Cited:	5	5	1	0	1	0	0	0	2	1
	Fix Priority:	2.3	2.2	2.0	NA	1.0	NA	NA	NA	1.5	--
098.	Rubber covers easily damaged or prone to wear?										
	Freq. Cited:	3	6	1	0	1	0	0	1	1	1
	Fix Priority:	1.3	2.2	3.0	NA	1.0	NA	NA	3.0	1.0	--
099.	The range (distance) of movement is too large?										
	Freq. Cited:	0	1	2	0	0	0	0	0	1	2
	Fix Priority:	NA	--	2.0	NA	NA	NA	NA	NA	2.0	3.0
100.	The range (distance) of movement is too small?										
	Freq. Cited:	2	0	0	0	2	1	0	1	2	0
	Fix Priority:	2.0	NA	NA	NA	3.0	2.0	NA	3.0	2.5	NA
101.	Hard to see in low light?										
	Freq. Cited:	3	3	5	2	9	5	0	3	10	2
	Fix Priority:	2.0	2.7	2.2	2.5	2.3	1.8	NA	1.5	2.3	3.0

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Table 7.5, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH CONTROL KNOBS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
102. Does not stop at the end of range (easy to overshoot last or first setting)?											
	Freq. Cited:	4	5	1	1	0	5	2	0	0	4
	Fix Priority:	2.0	2.2	--	3.0	NA	2.2	1.0	NA	NA	2.0
103. Detents ("click stops" at settings) too soft or too hard?											
	Freq. Cited:	5	2	0	0	1	0	0	0	1	1
	Fix Priority:	1.8	1.5	NA	NA	1.0	NA	NA	NA	1.0	3.0
104. Reference marks hard to see under normal light (from your normal operating position)?											
	Freq. Cited:	3	0	2	0	6	2	0	2	3	0
	Fix Priority:	1.7	NA	1.5	NA	2.2	3.0	NA	3.0	2.3	NA
105. Reference marks hard to see from other position?											
	Freq. Cited:	5	3	1	0	6	2	1	2	6	1
	Fix Priority:	1.4	2.3	2.0	NA	2.0	2.5	2.0	2.5	2.3	--
106. Shape does not show which way knob is pointing?											
	Freq. Cited:	2	3	2	0	0	5	1	1	2	0
	Fix Priority:	1.5	2.3	1.0	NA	NA	1.8	1.0	--	3.0	NA
107. Hard to see where knob is pointing when viewed from side angles?											
	Freq. Cited:	3	5	2	2	5	5	2	5	8	1
	Fix Priority:	1.7	2.2	2.0	2.5	1.6	1.8	2.0	2.5	2.1	--
108. Hard to see where knob is pointing when viewed from above or below?											
	Freq. Cited:	4	3	0	1	3	4	2	2	7	1
	Fix Priority:	1.8	2.5	NA	3.0	2.0	2.0	2.0	3.0	2.1	--

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Table 7.5, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH CONTROL KNOBS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
109.	Poor design for turning?										
	Freq. Cited:	0	1	1	0	1	1	1	2	1	0
	Fix Priority:	NA	2.0	--	NA	1.0	2.0	3.0	2.5	2.0	NA
110.	Hard to feel where knob is pointing?										
	Freq. Cited:	1	5	2	1	3	4	2	1	4	0
	Fix Priority:	2.0	2.4	1.5	2.0	2.0	1.7	2.0	3.0	2.7	NA
111.	Accidental movement of knob?										
	Freq. Cited:	4	3	1	2	0	1	0	1	0	2
	Fix Priority:	1.3	2.0	3.0	2.5	NA	2.0	NA	--	NA	--
112.	Accidentally turn past desired setting?										
	Freq. Cited:	4	4	2	1	1	6	1	2	2	3
	Fix Priority:	1.5	1.8	2.0	2.0	1.0	1.8	1.0	3.0	1.5	2.0
113.	Poor volume control?										
	Freq. Cited:	1	3	2	0	3	1	1	0	4	1
	Fix Priority:	3.0	2.0	2.0	NA	2.7	3.0	3.0	NA	2.5	--
114.	Poor squelch control?										
	Freq. Cited:	0	0	0	0	0	1	0	0	0	2
	Fix Priority:	NA	NA	NA	NA	NA	2.0	NA	NA	NA	1.0
115.	Certain power setting doesn't work right?										
	Freq. Cited:	0	1	0	0	1	1	0	0	2	1
	Fix Priority:	NA	2.0	NA	NA	3.0	1.0	NA	NA	1.0	--
116.	Control for display light doesn't work well?										
	Freq. Cited:	0	0	0	0	0	4	1	4	1	2
	Fix Priority:	NA	NA	NA	NA	NA	2.5	3.0	1.3	--	--

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Table 7.5, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH CONTROL KNOBS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
117. Hard to use control while in MOPP (NBC) gear?											
	Freq. Cited:	0	1	0	0	1	2	0	0	0	0
	Fix Priority:	NA	3.0	NA	NA	2.0	1.0	NA	NA	NA	NA
118. Knob has poor "feel"?											
	Freq. Cited:	1	0	1	0	1	0	1	0	1	0
	Fix Priority:	2.0	NA	--	NA	--	NA	3.0	NA	2.0	NA
119. Handset push-to-talk doesn't work well?											
	Freq. Cited:	2	0	1	3	3	0	1	1	5	2
	Fix Priority:	2.0	NA	--	3.0	1.0	NA	2.0	--	2.5	2.0
120. Other handset features don't work well?											
	Freq. Cited:	1	0	2	1	3	1	0	1	3	2
	Fix Priority:	2.0	NA	3.0	--	1.5	3.0	NA	--	2.5	--

Table 7.6

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
LABEL PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
121.	Labels are prone to damage (from rubbing, scratching, or wearing off)?										
	Freq. Cited:	2	0	1	0	1	2	0	0	6	0
	Fix Priority:	1.5	NA	--	NA	1.0	2.5	NA	NA	1.8	NA
122.	Exact meaning of label unclear, especially to new operator?										
	Freq. Cited:	1	1	1	1	3	1	7	3	3	0
	Fix Priority:	1.0	2.0	1.0	3.0	1.7	2.0	2.4	1.5	1.7	NA
123.	Poor choice of word or symbol for label?										
	Freq. Cited:	0	1	1	0	0	0	6	0	3	1
	Fix Priority:	NA	1.0	1.0	NA	NA	NA	2.4	NA	1.5	--
124.	One label is not consistent with another?										
	Freq. Cited:	0	0	0	0	0	1	1	0	1	0
	Fix Priority:	NA	NA	NA	NA	NA	2.0	--	NA	2.0	NA
125.	Label would make more sense if different word or symbol were used?										
	Freq. Cited:	1	1	2	1	1	1	6	2	4	0
	Fix Priority:	1.0	2.0	1.0	--	3.0	1.0	2.0	1.5	1.0	NA
126.	Control is used for things that are not indicated by label?										
	Freq. Cited:	1	1	0	0	1	2	0	0	0	0
	Fix Priority:	1.0	2.0	NA	NA	1.0	1.0	NA	NA	NA	NA
127.	Label indicates something the control will not do?										
	Freq. Cited:	1	0	1	0	0	0	0	0	0	0
	Fix Priority:	1.0	NA	--	NA	NA	NA	NA	NA	NA	NA
128.	One or more keys on keyboard/keypad are not labeled for everything they do?										
	Freq. Cited:	4	0	1	0	5	0	0	2	1	0
	Fix Priority:	1.3	NA	1.0	NA	1.8	NA	NA	2.0	--	NA

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Table 7.6, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
LABEL PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
129. There are one or more unnecessary labels on the radio?											
	Freq. Cited:	0	0	0	0	0	2	1	0	1	0
	Fix Priority:	NA	NA	NA	NA	NA	1.5	3.0	NA	2.0	NA
130. One label can be easily confused with another?											
	Freq. Cited:	0	1	0	0	2	3	2	0	2	1
	Fix Priority:	NA	2.0	NA	NA	1.5	2.0	2.5	NA	1.5	--
131. Abbreviation on label not meaningful?											
	Freq. Cited:	0	0	1	1	0	1	2	2	2	0
	Fix Priority:	NA	NA	--	3.0	NA	2.0	2.5	2.0	1.0	NA
132. Can't easily tell which control label refers to?											
	Freq. Cited:	0	1	1	0	0	2	3	2	1	1
	Fix Priority:	NA	--	--	NA	NA	2.0	3.0	2.0	1.0	--
133. Hard to read important label in low light?											
	Freq. Cited:	5	6	5	3	9	5	4	5	7	2
	Fix Priority:	2.6	2.3	2.4	2.0	2.1	2.0	2.0	2.7	2.2	2.5
134. Hard to see where control is set because label is poor?											
	Freq. Cited:	1	1	2	0	1	1	2	0	0	0
	Fix Priority:	2.0	2.0	2.0	NA	--	2.0	3.0	NA	NA	NA
135. Hard to read label while in MOPP (NBC) gear?											
	Freq. Cited:	0	0	0	1	0	0	1	0	0	0
	Fix Priority:	NA	NA	NA	--	NA	NA	3.0	NA	NA	NA

Table 7.7

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH INDICATORS ("BEEPS," TONES, LIGHTS, ETC.)

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
136. No indicator to tell when radio is on?											
	Freq. Cited:	1	6	1	0	1	3	0	3	4	5
	Fix Priority:	1.0	2.2	3.0	NA	--	1.7	NA	1.0	2.3	3.0
137. Problem with signal strength meter?											
	Freq. Cited:	0	0	1	0	0	0	0	1	1	0
	Fix Priority:	NA	NA	2.0	NA	NA	NA	NA	3.0	3.0	NA
138. Problem with sidetone in handset?											
	Freq. Cited:	3	1	1	0	1	2	2	0	0	0
	Fix Priority:	2.3	3.0	2.0	NA	3.0	2.0	1.5	NA	NA	NA
139. "Beep" or other tone signal is hard to hear when vehicle engine is running (or with other noise)?											
	Freq. Cited:	3	4	1	1	3	6	2	2	4	2
	Fix Priority:	2.3	2.8	3.0	3.0	2.0	2.2	1.5	2.0	2.8	--
140. Beep or tone is annoying?											
	Freq. Cited:	7	5	1	1	5	3	1	3	5	1
	Fix Priority:	1.7	1.8	1.0	2.0	1.6	2.0	2.0	3.0	1.8	--
141. Beep or tone is not needed?											
	Freq. Cited:	2	1	0	1	2	2	1	4	2	0
	Fix Priority:	2.0	3.0	NA	3.0	3.0	2.0	--	2.8	2.0	NA
142. Beep or tone is dangerous because it is too loud?											
	Freq. Cited:	5	2	1	1	1	0	0	3	3	0
	Fix Priority:	2.4	3.0	2.0	3.0	2.0	NA	NA	2.3	3.0	NA
143. Beep or tone is not loud enough?											
	Freq. Cited:	0	1	1	1	1	1	0	1	1	2
	Fix Priority:	NA	--	2.0	1.0	--	3.0	NA	2.0	1.0	--

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Table 7.7, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH INDICATORS ("BEEPS," TONES, LIGHTS, ETC.)

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
144. Meaning of signal is unclear?											
	Freq. Cited:	2	1	1	0	3	1	0	1	1	1
	Fix Priority:	2.5	1.0	2.0	NA	1.3	2.0	NA	2.0	2.0	--

Table 7.8

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH CONNECTOR PLUGS, RECEPTACLES, AND CABLES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
145.	Receptacles too crowded or too close to other controls?										
	Freq. Cited:	0	7	5	2	9	4	1	3	5	4
	Fix Priority:	NA	2.7	2.0	2.0	1.9	3.0	2.0	1.7	2.0	2.8
146.	Too many receptacles on front panel?										
	Freq. Cited:	0	7	1	0	4	1	0	0	1	0
	Fix Priority:	NA	2.8	1.0	NA	1.5	1.0	NA	NA	3.0	NA
147.	Receptacle is located in inconvenient position?										
	Freq. Cited:	0	5	4	2	3	1	4	2	1	5
	Fix Priority:	NA	2.0	1.7	2.0	2.0	2.0	1.8	2.0	3.0	1.8
148.	Receptacle has poor or no protective cap?										
	Freq. Cited:	10	0	3	4	0	0	0	0	0	1
	Fix Priority:	1.9	NA	2.0	2.5	NA	NA	NA	NA	NA	--
149.	Protective cap is not well attached?										
	Freq. Cited:	2	1	2	0	0	0	0	1	1	2
	Fix Priority:	2.0	2.0	--	NA	NA	NA	NA	--	2.0	3.0
150.	Retaining cords or straps on caps get in the way?										
	Freq. Cited:	0	4	3	1	4	3	0	2	3	3
	Fix Priority:	NA	2.0	2.0	--	2.3	2.0	NA	2.0	1.3	2.7
151.	Cap slips off receptacle too easily?										
	Freq. Cited:	0	1	0	0	0	2	0	0	0	0
	Fix Priority:	NA	2.0	NA	NA	NA	1.5	NA	NA	NA	NA
152.	Too hard to get cap off?										
	Freq. Cited:	0	0	1	0	0	0	1	0	0	0
	Fix Priority:	NA	NA	3.0	NA	NA	NA	1.0	NA	NA	NA

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Table 7.8, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH CONNECTOR PLUGS, RECEPTACLES, AND CABLES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
153. Receptacle is not sturdy, i.e., can get damaged easily?											
	Freq. Cited:	1	1	0	0	2	3	2	0	1	1
	Fix Priority:	2.0	2.0	NA	NA	1.0	3.0	2.0	NA	1.0	--
154. Part of control can come off and get lost?											
	Freq. Cited:	0	1	0	0	1	0	0	0	0	0
	Fix Priority:	NA	--	NA	NA	--	NA	NA	NA	NA	NA
155. Screw threads on connector too fine or too course?											
	Freq. Cited:	1	0	0	0	0	5	0	0	2	0
	Fix Priority:	1.0	NA	NA	NA	NA	2.8	NA	NA	3.0	NA
156. Hard to connect or remove connector because of lack of space for fingers?											
	Freq. Cited:	2	5	4	2	6	8	4	5	5	5
	Fix Priority:	2.0	2.5	2.0	3.0	1.5	3.0	2.0	1.8	2.2	2.3
157. Must remove a connector to make room for fingers while inserting a different connector?											
	Freq. Cited:	0	2	4	2	3	5	2	2	1	1
	Fix Priority:	NA	2.0	2.5	2.5	2.0	2.6	2.5	2.5	3.0	--
158. Hard to line up connector with receptacle because there are no marks (or poor marks) to show the correct position?											
	Freq. Cited:	2	1	1	0	2	3	0	1	3	1
	Fix Priority:	2.0	3.0	3.0	NA	2.0	2.7	NA	3.0	2.0	--
159. Can put connector in wrong receptacle?											
	Freq. Cited:	1	3	4	0	2	0	0	2	1	0
	Fix Priority:	1.0	1.5	2.5	NA	2.0	NA	NA	1.5	--	NA

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Table 7.8, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH CONNECTOR PLUGS, RECEPTACLES, AND CABLES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
160.	Possible to put connector in right receptacle but wrong position?										
	Freq. Cited:	1	0	2	0	1	2	0	0	2	0
	Fix Priority:	2.0	NA	1.5	NA	1.0	2.0	NA	NA	2.0	NA
161.	Label doesn't say that receptacle has more than one purpose?										
	Freq. Cited:	4	1	3	0	3	2	0	1	3	0
	Fix Priority:	1.3	1.0	2.0	NA	1.3	3.0	NA	3.0	1.7	NA
162.	Too much force required to insert or remove connector?										
	Freq. Cited:	2	2	5	0	1	2	0	3	3	0
	Fix Priority:	2.0	2.5	2.6	NA	3.0	2.0	NA	2.0	2.5	NA
163.	Cable does not have quick-connector (one turn)?										
	Freq. Cited:	3	2	0	1	1	1	2	1	2	2
	Fix Priority:	3.0	1.0	NA	1.0	1.0	2.0	--	--	2.0	3.0
164.	Cable gets in the way of operating controls?										
	Freq. Cited:	0	3	0	0	3	3	0	0	4	4
	Fix Priority:	NA	2.0	NA	NA	2.0	2.0	NA	NA	2.0	2.3
165.	Cable obstructs view of front panel?										
	Freq. Cited:	0	5	1	0	0	2	0	0	3	4
	Fix Priority:	NA	2.5	--	NA	NA	2.5	NA	NA	2.5	2.5
166.	Cable too long?										
	Freq. Cited:	0	2	0	1	0	3	0	0	2	2
	Fix Priority:	NA	3.0	NA	2.0	NA	2.7	NA	NA	1.5	1.0
167.	Cable too short?										
	Freq. Cited:	1	1	0	0	0	0	0	0	2	0
	Fix Priority:	1.0	--	NA	NA	NA	NA	NA	NA	3.0	NA

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Table 7.8, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH CONNECTOR PLUGS, RECEPTACLES, AND CABLES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
168.	Cables get tangled up?										
	Freq. Cited:	2	6	0	1	0	2	0	0	6	0
	Fix Priority:	1.5	2.0	NA	2.0	NA	2.5	NA	NA	1.7	NA
169.	Cable should be of coiled type, but isn't?										
	Freq. Cited:	0	2	0	5	0	1	1	0	6	0
	Fix Priority:	NA	1.0	NA	2.5	NA	1.0	3.0	NA	2.0	NA
170.	Hard to connect antenna to radio?										
	Freq. Cited:	0	0	7	3	0	3	4	0	0	0
	Fix Priority:	NA	NA	2.1	2.7	NA	2.3	1.8	NA	NA	NA
171.	Hard to connect antenna to vehicle?										
	Freq. Cited:	0	0	1	0	0	0	0	0	0	0
	Fix Priority:	NA	NA	--	NA	NA	NA	NA	NA	NA	NA
172.	Hard to connect antenna in MOPP (NBC) gear?										
	Freq. Cited:	0	0	0	1	0	0	1	0	0	0
	Fix Priority:	NA	NA	NA	2.0	NA	NA	1.0	NA	NA	NA
173.	Poor electrical contact?										
	Freq. Cited:	0	0	0	0	0	1	0	0	0	0
	Fix Priority:	NA	NA	NA	NA	NA	3.0	NA	NA	NA	NA
174.	The radio self-test shows failure but does not tell what part of the radio has failed?										
	Freq. Cited:	2	1	3	1	2	0	4	2	1	1
	Fix Priority:	3.0	3.0	2.7	3.0	1.0	NA	1.7	2.0	3.0	3.0
175.	Problem connecting VINSON (KY-57)?										
	Freq. Cited:	0	5	5	0	3	1	0	0	2	0
	Fix Priority:	NA	2.0	2.0	NA	1.5	3.0	NA	NA	3.0	NA

Table 7.9

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH OPERATING PROCEDURES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
176.	Problem with PMCS (preventive maintenance, checks, and services)?										
	Freq. Cited:	0	0	0	0	0	0	1	0	0	0
	Fix Priority:	NA	NA	NA	NA	NA	NA	1.0	NA	NA	NA
177.	Troubleshooting problem?										
	Freq. Cited:	1	0	1	0	0	0	0	0	0	1
	Fix Priority:	3.0	NA	3.0	NA	NA	NA	NA	NA	NA	3.0
178.	Procedure described correctly in manual?										
	Freq. Cited:	3	2	7	4	5	4	0	2	5	4
	Fix Priority:	3.0	1.0	--	2.0	1.0	--	NA	--	2.0	--
179.	Procedure hard to learn?										
	Freq. Cited:	0	0	2	0	0	0	0	0	1	0
	Fix Priority:	NA	NA	2.5	NA	NA	NA	NA	NA	3.0	NA
180.	Procedure easy to do wrong?										
	Freq. Cited:	2	0	5	0	1	1	0	1	2	2
	Fix Priority:	2.5	NA	2.2	NA	1.0	1.0	NA	2.0	2.5	3.0
181.	Frequency hopping procedure confusing?										
	Freq. Cited:	1	0	2	1	0	1	0	2	2	0
	Fix Priority:	3.0	NA	2.0	2.0	NA	1.0	NA	1.5	2.0	NA
182.	Frequency hopping procedure hard to do?										
	Freq. Cited:	1	0	2	0	0	1	0	0	0	0
	Fix Priority:	3.0	NA	2.0	NA	NA	--	NA	NA	NA	NA
183.	Frequency hopping procedure easy to forget?										
	Freq. Cited:	1	0	2	0	2	1	0	2	0	0
	Fix Priority:	3.0	NA	2.0	NA	1.5	1.0	NA	1.5	NA	NA

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Table 7.9, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH OPERATING PROCEDURES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
184.	Hard to re-enter net after losing communications?										
	Freq. Cited:	1	3	6	1	2	4	0	0	0	1
	Fix Priority:	3.0	2.0	2.8	3.0	2.0	2.0	NA	NA	NA	3.0
185.	Things happen too fast during any procedure?										
	Freq. Cited:	0	0	3	1	1	1	0	0	0	1
	Fix Priority:	NA	NA	2.0	2.0	3.0	3.0	NA	NA	NA	2.0
186.	Procedure is not logical?										
	Freq. Cited:	0	0	0	1	0	0	0	1	1	1
	Fix Priority:	NA	NA	NA	2.0	NA	NA	NA	1.0	2.0	--
187.	Wrong procedure might damage the radio?										
	Freq. Cited:	0	1	0	0	1	0	0	0	1	1
	Fix Priority:	NA	--	NA	NA	1.0	NA	NA	NA	2.0	--
188.	Time of synchronization problem?										
	Freq. Cited:	3	0	5	1	1	6	0	0	1	0
	Fix Priority:	2.3	NA	2.8	2.0	1.0	2.3	NA	NA	3.0	NA
189.	ERF (electronic remote fill) problem?										
	Freq. Cited:	0	0	4	0	0	0	0	0	0	1
	Fix Priority:	NA	NA	2.8	NA	NA	NA	NA	NA	NA	2.0
190.	Problem with CUE (page/rescue/clear net) procedure?										
	Freq. Cited:	0	1	1	2	2	2	0	2	5	0
	Fix Priority:	NA	--	2.0	3.0	2.0	--	NA	2.0	2.8	NA
191.	Problem loading or setting single frequencies?										
	Freq. Cited:	0	0	0	0	0	0	0	0	0	0
	Fix Priority:	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Table 7.9, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH OPERATING PROCEDURES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
192.	Problem loading or setting hopset or net ID's?										
	Freq. Cited:	1	0	0	0	0	2	0	1	0	0
	Fix Priority:	1.0	NA	NA	NA	NA	1.5	NA	2.0	NA	NA
193.	Problem loading any other information into radio?										
	Freq. Cited:	1	0	2	0	0	1	0	0	0	0
	Fix Priority:	3.0	NA	3.0	NA	NA	--	NA	NA	NA	NA
194.	Problem entering or reentering net?										
	Freq. Cited:	1	2	5	0	2	0	0	1	1	0
	Fix Priority:	3.0	2.0	2.6	NA	2.0	NA	NA	3.0	3.0	NA
195.	Problem establishing a secure net?										
	Freq. Cited:	1	2	1	1	2	3	0	0	2	2
	Fix Priority:	2.0	3.0	3.0	--	2.0	2.0	NA	NA	2.5	2.0
196.	Problem interfacing with VINSON (KY-57)?										
	Freq. Cited:	0	7	5	5	9	3	1	0	2	2
	Fix Priority:	NA	3.0	2.8	2.5	2.5	2.7	1.0	NA	3.0	2.0
197.	Problem interfacing with DMD (digital message device)?										
	Freq. Cited:	1	5	5	2	3	2	3	1	2	2
	Fix Priority:	2.0	2.8	2.6	3.0	2.5	2.0	2.3	2.0	3.0	3.0
198.	Problem interfacing with remote control unit (an/GRA-39)?										
	Freq. Cited:	0	0	0	0	0	0	0	0	1	0
	Fix Priority:	NA	NA	NA	NA	NA	NA	NA	NA	3.0	NA
199.	Problem interfacing with VFMED?										
	Freq. Cited:	0	1	0	0	0	2	0	0	0	0
	Fix Priority:	NA	3.0	NA	NA	NA	2.0	NA	NA	NA	NA

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Table 7.9, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH OPERATING PROCEDURES

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
200.	Problem interfacing with BCS?										
	Freq. Cited:	0	0	2	0	2	0	1	0	0	0
	Fix Priority:	NA	NA	3.0	NA	2.5	NA	1.0	NA	NA	NA
201.	Problem changing from single (fixed) frequency to frequency hopping?										
	Freq. Cited:	0	0	1	1	0	0	0	0	0	0
	Fix Priority:	NA	NA	3.0	3.0	NA	NA	NA	NA	NA	NA
202.	Problem with procedure for sending data in secure (cipher) mode?										
	Freq. Cited:	2	3	3	3	3	1	0	0	1	1
	Fix Priority:	2.5	3.0	2.7	3.0	3.0	3.0	NA	NA	3.0	3.0
203.	Poor or no battery check available?										
	Freq. Cited:	0	0	0	1	0	2	0	0	4	5
	Fix Priority:	NA	NA	NA	--	NA	2.5	NA	NA	2.7	2.7
204.	Poor or no procedure for self-test, or "built-in-test" (BIT)?										
	Freq. Cited:	1	0	0	0	1	0	0	1	3	2
	Fix Priority:	3.0	NA	NA	NA	3.0	NA	NA	2.0	2.7	2.0
205.	The self-test sometimes says something is wrong when everything is really okay?										
	Freq. Cited:	0	1	4	0	0	1	0	0	0	0
	Fix Priority:	NA	3.0	1.7	NA	NA	1.0	NA	NA	NA	NA

Table 7.10

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH MANPACK (BACKPACK) RADIO

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
206. Problem mounting KY-57 (VINSON) on manpack?											
	Freq. Cited:	0	4	0	4	1	4	0	0	0	3
	Fix Priority:	NA	2.8	NA	2.7	3.0	2.8	NA	NA	NA	2.0
207. Manpack straps too short?											
	Freq. Cited:	0	2	0	1	2	1	0	1	0	2
	Fix Priority:	NA	2.0	NA	3.0	3.0	3.0	NA	--	NA	2.5
208. VINSON on manpack (backpack) causes balance problems?											
	Freq. Cited:	0	3	0	3	1	2	0	0	0	0
	Fix Priority:	NA	3.0	NA	3.0	3.0	3.0	NA	NA	NA	NA
209. Manpack too heavy?											
	Freq. Cited:	0	3	1	1	4	2	0	2	2	2
	Fix Priority:	NA	3.0	3.0	1.0	2.7	3.0	NA	--	2.0	3.0
210. Other problem carrying manpack?											
	Freq. Cited:	1	0	1	0	2	0	0	1	1	0
	Fix Priority:	1.0	NA	2.0	NA	3.0	NA	NA	3.0	1.0	NA
211. No place to carry handset while walking with manpack?											
	Freq. Cited:	0	1	2	1	2	2	0	1	0	1
	Fix Priority:	NA	3.0	1.5	--	3.0	2.0	NA	3.0	NA	--
212. Difficulty getting manpack radio to stand up when using it on the ground?											
	Freq. Cited:	2	2	4	2	1	4	0	2	2	3
	Fix Priority:	3.0	3.0	2.3	2.0	3.0	2.3	NA	3.0	1.5	2.5
213. Battery installation difficult?											
	Freq. Cited:	0	1	0	1	0	0	0	0	1	0
	Fix Priority:	NA	--	NA	2.0	NA	NA	NA	NA	3.0	NA

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Table 7.10, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
PROBLEMS WITH MANPACK (BACKPACK) RADIO

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
214. Clips on battery case hard to operate?											
	Freq. Cited:	3	0	3	1	0	0	0	1	2	0
	Fix Priority:	1.3	NA	2.5	2.0	NA	NA	NA	3.0	2.0	NA
215. Electrical contacts on battery easy to damage?											
	Freq. Cited:	0	1	0	0	0	0	0	0	0	0
	Fix Priority:	NA	2.0	NA	NA	NA	NA	NA	NA	NA	NA

Table 7.11

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results:
MISCELLANEOUS PROBLEMS

Item	Radio: (N):	ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
216.	Front panel needs additional lighting at night or in low light conditions?										
	Freq. Cited:	8	5	4	3	8	8	0	8	7	4
	Fix Priority:	2.4	2.8	2.0	3.0	1.9	2.9	NA	2.7	2.2	2.5
217.	Handles on radio get in the way?										
	Freq. Cited:	0	0	2	0	1	1	0	1	0	1
	Fix Priority:	NA	NA	2.0	NA	3.0	2.0	NA	2.0	NA	2.0
218.	Handles are not strong?										
	Freq. Cited:	1	0	1	1	0	0	0	1	0	0
	Fix Priority:	--	NA	2.0	3.0	NA	NA	NA	--	NA	NA
219.	Required tool for radio was not available to operator?										
	Freq. Cited:	0	1	3	0	1	0	0	1	1	0
	Fix Priority:	NA	--	2.5	NA	--	NA	NA	2.0	1.0	NA
220.	Problem with handset?										
	Freq. Cited:	4	0	1	4	5	1	3	0	4	1
	Fix Priority:	2.3	NA	2.0	2.5	2.4	3.0	1.3	NA	3.0	1.0
221.	Received accidental "shock" or "burn" from antenna during transmission or radio self-test?										
	Freq. Cited:	0	4	0	0	0	2	0	0	0	0
	Fix Priority:	NA	3.0	NA	NA	NA	2.0	NA	NA	NA	NA
222.	Base of whip antenna too flexible?										
	Freq. Cited:	2	1	1	0	0	3	1	1	0	0
	Fix Priority:	1.5	3.0	2.0	NA	NA	2.0	3.0	3.0	NA	NA
223.	Base of whip antenna too stiff?										
	Freq. Cited:	0	0	0	3	0	3	0	0	1	0
	Fix Priority:	NA	NA	NA	2.5	NA	1.0	NA	NA	2.0	NA

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Table 7.11, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results: MISCELLANEOUS PROBLEMS

> Note: The following items were presented in the questionnaire in varying formats. In items 224 and 225, the data are frequencies; in the others, the mean (M), standard deviation (SD), and number of respondents (N) are shown.

Item	Radio: (N):		ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
224.	Did you take your operator's manual to the field with you?											
	Yes	Y:	6	4	10	2	9	6	NA	1	3	2
	No	N:	6	7	2	10	3	6	NA	10	8	10
225.	Did you use your operator's manual in the field?											
	Yes	Y:	4	3	10	2	3	3	NA	0	0	2
	No	N:	8	8	2	9	9	9	NA	11	11	10
226.	Was your manual easy to use?											
	1--Very easy											
	2--Easy	M:	2.2	1.7	2.2	1.8	1.8	1.8	NA	2.3	3.0	1.6
	3--Borderline	SD:	0.7	0.9	0.8	0.6	0.8	0.7	NA	1.3	0.6	0.7
	4--Hard	N:	10	7	12	9	11	10	NA	7	6	9
	5--Very hard											
227.	Does your manual need revisions?											
	1--Very few, or none											
	2--A few	M:	1.9	1.6	2.0	2.0	2.0	1.9	NA	2.1	2.8	1.4
	3--Some	SD:	0.7	0.9	1.0	0.9	1.0	0.8	NA	1.2	1.2	0.7
	4--Many	N:	11	7	12	9	11	10	NA	8	9	9
	5--Very many											

[Continued on next page]

Table 7.11, continued

Post-Field-Exercise MANPRINT Evaluation Questionnaire Results: MISCELLANEOUS PROBLEMS

Item	Radio: (N):		ERI (12)	HAR (11)	ITT (12)	MAR (12)	RAC (12)	ROC (12)	SEL (13)	TAD (11)	THO (11)	TWC (12)
228.	Is your manual durable enough for long-term use in the field?											
	1--Definitely yes 2--Probably yes 3--Borderline 4--Probably no 5--Definitely no	M:	4.3	3.7	2.7	1.9	4.0	2.7	NA	2.7	3.1	2.4
		SD:	0.8	1.4	1.0	0.9	0.9	0.8	NA	0.8	0.9	1.2
		N:	10	9	12	9	11	10	NA	8	8	11
229.	How long should a training class for your radio be?											
	1--One-half day 2--One day 3--Two days 4--Three days 5--Four days 6--Five days or more	M:	4.0	3.9	5.6	4.4	5.2	3.8	4.2	4.6	5.5	3.7
		SD:	0.9	0.8	0.8	1.0	0.8	1.4	0.8	1.1	0.8	1.5
		N:	12	11	12	12	12	11	12	11	11	12
230.	How much radio operation experience did you have prior to the training you received for this test? 1--A lot (including formal training) 2--Fair amount ("hands-on" experience and/or training) 3--Some (a few hours of experience) 4--A little (a little training, no significant experience) 5--Very little, or none											
		M:	2.0	2.5	2.1	2.2	2.2	2.1	2.2	1.9	1.8	1.6
		SD:	1.5	1.4	1.0	0.9	0.7	1.2	1.2	1.2	0.8	0.8
		N:	12	11	12	12	12	11	12	11	11	12

Table 8

Comparison of Radios by Problem Area and Vendor
(Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Problem Area	Rank/ Freq.	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
Communications	R:	4	7	10	5	6	9	1	2	8	3
	F:	35	68	79	46	58	71	9	23	70	24
Keyboard (Keypad)	R:	6	NA	2	1	4	NA	NA	3	5	NA
	F:	34	NA	14	4	22	NA	NA	17	32	NA
Display	R:	6.5	6.5	4	2	5	10	1	9	8	3
	F:	46	46	36	32	39	80	11	69	53	34
Toggles/ Buttons	R:	1	10	8	7	4	5.5	9	2.5	5.5	2.5
	F:	7	23	14	13	11	12	18	10	12	10
Control Knobs	R:	6	9	3	1	8	7	4	5	10	2
	F:	60	74	38	22	70	63	39	45	89	36
	R:	4	3	5	2	8	7	9	6	10	2
Labels	F:	15	14	16	7	23	21	32	17	34	5
Indicators	R:	8.5	8.5	3	1	5	6	2	7	10	4
	F:	23	23	8	5	17	18	6	20	24	11
Connectors & Cables	R:	4	10	8	2	6	7	1	3	9	5
	F:	34	74	59	26	50	58	24	27	65	36
Operating Procedures	R:	3	6	10	4	7.5	9	1	2	7.5	5
	F:	21	31	68	24	37	38	6	15	37	26
Backpack	R:	2	10	5.5	8	7	9	1	3.5	3.5	5.5
	F:	6	19	11	14	13	15	0	9	9	11
Miscellaneous	R:	8.5	4.5	4.5	3	8.5	10	1	6	7	2
	F:	15	12	12	11	15	18	4	13	14	6
Composite Summary	R:	5	8	6.5	3	6.5	9	1	4	10	2
	F:	296	383	355	204	355	394	148	265	440	199

Table 9.1

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Communication Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
004. Static or electronic interference from M60A1 engine.	.	.	.	.	.	ROC	.	.	.	.
005. Other static problems.	.	HAR	ITT	MAR	RAC	ROC	.	.	THO	.
006. Bad weather produced poor communications.	.	.	ITT	.	.	.	.	.	THO	.
008. Background noise made it hard to hear in handset.	ERI	HAR	ITT	.	RAC	ROC	.	.	THO	.
009. Background noise made it hard to hear speaker.	.	.	ITT	.	.	ROC	.	TAD	THO	.
010. Loss of communication using VINSON (KY-57).	.	HAR	ITT	MAR	RAC	ROC	.	.	.	TWC
011. Volume problems when using VINSON (KY-57).	.	HAR	ITT	.	RAC	.	.	.	.	.
012. Static or poor sound quality with VINSON (KY-57)	.	HAR	ITT	MAR	RAC	ROC	.	.	.	.
013. Static or poor sound quality with remote hookup.	.	.	.	.	RAC	.	.	.	.	.
014. Problem understanding voice communication in frequency-hopping mode.	.	.	ITT	MAR	.	ROC	.	.	.	.
017. Problem sending a CUE call (page/rescue/clear net).	.	.	.	.	.	.	.	TAD	THO	.
020. Accidental or unexplained loss of information loaded into the radio (frequencies, time, etc.).	.	.	ITT	.	.	.	.	.	.	.
024. Poor voice-transmission quality while frequency hopping?	ERI	.	ITT	.	.	ROC	.	.	.	.

[Continued on next page]

Table 9.1, continued

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Communication Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
027. Problem sending data in frequency-hopping mode.	ERI	.	ITT	MAR	.	ROC	.	.	THO	.
Total:	3	5	11	5	6	9	0	2	6	1
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.2

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Keyboard (Keypad) Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
030. Have to push keys too hard.	ERI	.	.	.	.	.	.	.	THO	.
032. Keys sometimes don't work right.	.	.	.	.	.	.	.	.	THO	.
033. Keys hard to read in low light.	ERI	.	ITT	.	RAC	.	.	TAD	THO	.
035. Some keys do things that are not labeled on them.	.	.	.	.	RAC	.	.	TAD	.	.
037. Keys are prone to damage or wear.	.	.	.	.	RAC	.	.	.	.	.
041. Keys too close together for operation while wearing MOPP (NBC) gloves.	ERI	.	.	.	.	.	.	.	.	.
Total:	3	0	1	0	3	0	0	2	3	0
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.3

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Display Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
043. Display not bright enough.	.	.	.	.	.	.	.	TAD	.	.
046. Bad reflections (glare).	ERI	.	.	.	.	ROC	.	.	.	.
049. Hard to read display in direct sunlight.	ERI	.	.	.	.	ROC	.	TAD	.	TWC
050. Hard to read in low light.	.	.	.	.	.	ROC	.	.	.	.
053. Letters and numbers too small.	.	.	.	.	.	.	.	TAD	.	.
054. Display light does not stay on long enough.	.	HAR	.	.	.	ROC	.	.	.	TWC
056. Hard to read display from normal operating position.	.	.	.	.	.	ROC	.	TAD	.	.
057. Poor readability from different angles.	ERI	HAR	.	.	.	ROC	.	TAD	THO	TWC
058. Poor readability from 6-foot distance.	ERI	.	.	.	.	ROC	.	TAD	THO	.
060. Some letters and numbers look alike.	.	.	.	MAR	RAC	.	.	.	.	.
075. Display window prone to damage (scratching, etc.).	.	.	.	.	RAC	.	.	.	THO	.
Total:	4	2	0	1	2	7	0	6	3	3
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.4

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Toggle/Button Switch Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
077. Too crowded (too close to other controls).	.	.	ITT	.	RAC	.	SEL	TAD	.	.
078. Too small.	.	.	.	.	.	.	SEL	.	.	.
080. Unsturdy (prone to damage).	.	HAR	.	.	.	.	.	.	.	.
082. Easy to switch accidentally.	.	.	.	MAR	.	.	.	.	.	TWC
Total:	0	1	1	1	1	0	2	1	0	1
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.5

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Control Knob Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
086. Poor arrangement of knobs on front panel.	.	.	.	.	RAC	.	.	.	.	.
088. Knobs too crowded (too close to each other or to other controls).	.	.	ITT	.	RAC	.	SEL	.	.	.
091. Too small.	.	.	.	.	.	.	SEL	.	.	.
093. Not strong enough.	.	.	.	.	.	.	.	.	THO	.
096. Too hard to turn.	.	.	.	.	.	.	SEL	.	.	.
097. Too easy to turn.	ERI	HAR	.	.	.	.	.	.	.	.
098. Rubber covers easily damaged or prone to wear.	.	HAR	.	.	.	.	.	.	.	.
101. Hard to see in low light.	.	.	ITT	.	RAC	ROC	.	.	THO	.
102. Does not stop at the end of range (easy to overshoot last or first setting).	ERI	HAR	.	.	.	ROC	.	.	.	TWC
103. Detents ("click stops" at settings) too soft or too hard.	ERI	.	.	.	.	.	.	.	.	.
104. Reference marks hard to see under normal light (from normal operating position).	.	.	.	.	RAC	.	.	.	.	.
105. Reference marks hard to see from other position.	ERI	.	.	.	RAC	.	.	.	THO	.
106. Shape does not show which way knob is pointing.	.	.	.	.	.	ROC	.	.	.	.
107. Hard to see where knob is pointing when viewed from side angles.	.	HAR	.	.	RAC	ROC	.	TAD	THO	.

[Continued on next page]

Table 9.5, continued

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Control Knob Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
108. Hard to see where knob is pointing when viewed from above or below.	ERI	.	.	.	.	ROC	.	.	THO	.
110. Hard to feel where knob is pointing.	.	HAR	.	.	.	ROC	.	.	THO	.
111. Accidental movement of knob.	ERI	.	.	.	.	.	.	.	.	.
112. Accidentally turn past desired setting.	ERI	HAR	.	.	.	ROC	.	.	.	.
113. Poor volume control.	.	.	.	.	.	.	.	.	THO	.
116. Control for display light doesn't work well.	.	.	.	.	.	ROC	.	TAD	.	.
119. Handset push-to-talk doesn't work well.	.	.	.	.	.	.	.	.	THO	.
Total:	7	6	2	0	6	8	3	2	8	1
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.6

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Label Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
121. Labels are prone to damage (from rubbing, scratching, or wearing off).	.	.	.	.	.	.	.	.	THO	.
122. Exact meaning of label unclear, especially to new operator.	.	.	.	.	.	.	SEL	.	.	.
123. Poor choice of word or symbol for label.	.	.	.	.	.	.	SEL	.	.	.
125. Label would make more sense if different word or symbol were used.	.	.	.	.	.	.	SEL	.	THO	.
128. One or more keys on keyboard/-keypad are not labeled for everything they do.	ERI	.	.	.	RAC	.	.	.	.	.
133. Hard to read important label in low light.	ERI	HAR	ITT	.	RAC	ROC	SEL	TAD	THO	.
Total:	2	1	1	0	2	1	4	1	3	0
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.7

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Indicator Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
136. No indicator to tell when radio is on.	.	HAR	.	.	.	.	.	.	THO	TWC
139. Beep or other tone signal is hard to hear when vehicle engine is running (or with other noise).	.	HAR	.	.	.	ROC	.	.	THO	.
140. Beep or tone is annoying.	ERI	HAR	.	.	RAC	.	.	.	THO	.
141. Beep or tone is not needed.	.	.	.	.	.	.	.	TAD	.	.
142. Beep or tone is dangerous because it is too loud.	ERI	.	.	.	.	.	.	.	.	.
Total:	2	3	0	0	1	1	0	1	3	1
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.8

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Problems with Connector Plugs, Receptacles, and Cables	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
145. Receptacles too crowded or too close to other controls.	.	HAR	ITT	.	RAC	ROC	.	.	THO	TWC
146. Too many receptacles on front panel.	.	HAR	.	.	RAC	.	.	.	.	.
147. Receptacle is located in inconvenient position.	.	HAR	ITT	.	.	.	SEL	.	.	TWC
148. Receptacle has poor or no protective cap.	ERI	.	.	MAR	.	.	.	.	.	.
150. Retaining cords or straps on caps get in the way.	.	HAR	.	.	RAC	.	.	.	.	.
155. Screw threads on connector too fine or too course.	.	.	.	.	.	ROC	.	.	.	.
156. Hard to connect or remove connector because of lack of space for fingers.	.	HAR	ITT	.	RAC	ROC	SEL	TAD	THO	TWC
157. Must remove a connector to make room for fingers while inserting a different connector.	.	.	ITT	.	.	ROC	.	.	.	.
159. Can put connector in wrong receptacle.	.	.	ITT	.	.	.	.	.	.	.
161. Label doesn't say that receptacle has more than one purpose.	ERI	.	.	.	.	.	.	.	.	.
162. Too much force required to insert or remove connector.	.	.	ITT	.	.	.	.	.	.	.
164. Cable gets in the way of operating controls.	.	.	.	.	.	.	.	.	THO	TWC
165. Cable obstructs view of front panel.	.	HAR	.	.	.	.	.	.	.	TWC

[Continued on next page]

Table 9.8, continued

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Problems with Connector Plugs, Receptacles, and Cables	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
168. Cables get tangled up.	.	HAR	.	.	.	.	.	.	THO	.
169. Cable should be of coiled type, but isn't.	.	.	.	MAR	.	.	.	.	THO	.
170. Hard to connect antenna to radio.	.	.	ITT	.	.	.	SEL	.	.	.
174. The radio self-test shows failure but does not tell what part of the radio has failed.	.	.	.	.	.	.	SEL	.	.	.
175. Problem connecting VINSON (KY-57)?	.	HAR	ITT	.	.	.	.	.	.	.
Total:	2	8	8	2	4	4	4	1	5	5
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.9

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Problems with Operating Procedures	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
178. Procedure [not] described correctly in manual.	.	.	ITT	MAR	RAC	ROC	.	.	THO	TWC
180. Procedure easy to do wrong.	.	.	ITT	.	.	.	.	.	.	.
184. Hard to re-enter net after losing communications.	.	.	ITT	.	.	ROC	.	.	.	.
188. Time or synchronization problem.	.	.	ITT	.	.	ROC	.	.	.	.
189. ERF (electronic remote fill) problem.	.	.	ITT	.	.	.	.	.	.	.
190. Problem with CUE (page/-rescue/clear net) procedure.	.	.	.	.	.	.	.	.	THO	.
194. Problem entering or reentering net.	.	.	ITT	.	.	.	.	.	.	.
196. Problem interfacing with VINSON (KY-57).	.	HAR	ITT	MAR	RAC	.	.	.	.	.
197. Problem interfacing with DMD (digital message device).	.	HAR	ITT	.	.	.	.	.	.	.
203. Poor or no battery check available.	.	.	.	.	.	.	.	.	THO	TWC
205. The self-test sometimes says something is wrong when everything is really okay.	.	.	ITT	.	.	.	.	.	.	.
Total:	0	2	9	2	2	3	0	0	3	2
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.10

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Problems with Backpack (Manpack) Configuration	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
206. Problem mounting KY-57 (VINSON) on manpack.	.	HAR	.	MAR	.	ROC	.	.	.	.
209. Manpack too heavy.	.	.	.	.	RAC	.	.	.	.	.
212. Difficulty getting manpack radio to stand up when using it on the ground.	.	.	ITT	.	.	ROC	.	.	.	.
Total:	0	1	1	1	1	2	0	0	0	0
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.11

Predominant Problems Cited by More than 30 Percent of Operators and Data Collectors (Post-Field-Exercise MANPRINT Evaluation Questionnaire)

Miscellaneous Problems	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
216. Front panel needs additional lighting at night or in low light conditions.	ERI	HAR	ITT	.	RAC	ROC	.	TAD	THO	TWC
220. Problem with handset.	ERI	.	.	MAR	RAC	.	.	.	THO	.
221. Received accidental "shock" or "burn" from antenna during transmission or radio self-test.	.	HAR	.	.	.	.	.	.	.	.
Total:	2	2	1	1	2	1	0	1	2	1
Radio:	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC

Table 9.12

Composite of Tables 9.1 through 9.11:
Number of Problems Cited by More than 30 Percent of Operators and Data Collectors (by Problem Area and Radio)

Problem Area	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
1. Communication	3	5	11	5	6	9	0	2	6	1
2. Keyboard	3	0	1	0	3	0	0	2	3	0
3. Display	4	2	0	1	2	7	0	6	3	3
4. Toggle/Button Switches	0	1	1	1	1	0	2	1	0	1
5. Control Knobs	7	6	2	0	6	8	3	2	8	1
6. Labels	2	1	1	0	2	1	4	1	3	0
7. Indicators	2	3	0	0	1	1	0	1	3	1
8. Connectors/-Cables	2	8	8	2	4	4	4	1	5	5
9. Operating Procedures	0	2	9	2	2	3	0	0	3	2
10. Backpack Configuration	0	1	1	1	1	2	0	0	0	0
11. Miscellaneous	2	2	1	1	2	1	0	1	2	1
Total:	25	31	35	13	30	36	13	17	36	15
Rank:	5	7	8	1.5	6	9.5	1.5	4	9.5	3

Table 10

Evaluation of Trainability

Index	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
1. Duration[A]	2.6	1.8	3.0	2.3	2.8	2.0	2.4	2.5	3.1	2.3
	3.4	3.3	4.7	3.7	4.4	3.2	3.7	3.9	4.6	3.2
	(3.0)	(2.6)	(3.9)	(3.0)	(3.6)	(2.6)	(3.1)	(3.2)	(3.9)	(2.8)
2. Difficulty[B]	1.7	1.9	1.8	2.2	2.0	2.4	2.1	1.6	2.2	2.0
3. Interest[C]	1.6	2.5	2.4	1.4	1.4	2.3	1.8	1.6	1.8	1.5
4. Adequacy[D]	1.6	1.7	2.1	1.3	1.8	1.4	1.6	1.5	1.8	1.3
5. Quality[E]	1.7	1.5	2.1	1.2	1.4	1.3	1.3	1.5	1.5	1.3
6. Manuals[F]	4.2	2.0	2.7	2.1	3.5	2.7	3.4	3.4	2.3	3.1
Overall Mean[G]	2.8	2.5	3.1	2.4	2.9	2.6	2.7	2.7	2.9	2.5
Overall Rank[H]	7	2.5	10	1	8.5	4	5.5	5.5	8.5	2.5

Note. All data based on a 5-point scale where 1 = best and 5 = worst.

[A]Source: 1st row, Post-Training MANPRINT Evaluation Questionnaire (PTMEQ), #132; second row, Post-Field-Exercise MANPRINT Evaluation Qustionnaire, #229, converted to scale. Numbers in parentheses are means.

[B]Source: PTMEQ, #134, converted to scale.

[C]Source: PTMEQ, #143.

[D]Source: PTMEQ, #149.

[E]Source: PTMEQ, #150, converted to scale.

[F]Source: Means from Table 6, converted to scale.

[G]Overall sum divided by 6.

[H]Ranks based on overall means. Ranks with decimals indicate ties.

Table 11

Evaluation of Operability

Radio	Post Training Radio Evaluation (Table 5)	Post Field Exercise Problems Cited (Table 8)		Post Field Exercise Predominant Problems (Table 9.12)	
	Scale Value	Total[A]	Scale Value	Total[B]	Scale Value
ERI	2.1	296	2.9	25	3.0
HAR	2.2	383	3.5	31	3.5
ITT	2.0	355	3.3	35	3.8
MAR	1.6	204	2.3	13	2.0
RAC	1.9	355	3.3	30	3.4
ROC	2.0	394	3.6	36	3.9
SEL	1.9	148	2.0	13	2.0
TAD	2.2	265	2.7	17	2.4
THO	2.4	440	3.9	36	3.9
TWC	2.1	199	2.3	15	2.2

Note. Scale values refer to a five-point scale where 1 = "good" and 5 = "poor."

[A]The frequencies in this column were converted to scale with the formula $Y = X/152 + 1$, where Y refers to the scale value and X to the frequency.

[B]The frequencies in this column were converted to scale with the formula $Y = 2X/25 + 1$, where Y refers to the scale value and X to the frequency.

TACTICAL NET RADIOS: NONDEVELOPMENTAL-ITEM OPERATIONAL ASSESSMENT (MANPRINT EVALUATION)

ANNEX A: DATA COLLECTION INSTRUMENTS

Contents

POST-TRAINING MANPRINT EVALUATION QUESTIONNAIRE

Name: ________________________ Radio: ________________ Date: ____________

******************* Section 1: Evaluation of RT Features *******************

Using the following scale, rate the radio on each of the many features listed below. (Circle one number for each feature.)

[+3] Extremely good
[+2] Very good
[+1] Good
[0] Borderline
[-1] Poor
[-2] Very poor
[-3] Extremely poor

DISPLAY FEATURES

01.	Location on panel	+3	+2	+1	0	-1	-2	-3
02.	Color of characters	+3	+2	+1	0	-1	-2	-3
03.	Brightness range (illumination)	+3	+2	+1	0	-1	-2	-3
04.	Reflections (absence of)	+3	+2	+1	0	-1	-2	-3
05.	Flicker (absence of)	+3	+2	+1	0	-1	-2	-3
06.	Readability (normal distance)	+3	+2	+1	0	-1	-2	-3
07.	Readability (6-foot distance)	+3	+2	+1	0	-1	-2	-3
08.	Readability from side angle	+3	+2	+1	0	-1	-2	-3
09.	Readability from high angle (looking down)	+3	+2	+1	0	-1	-2	-3
10.	Readability from low angle (looking up)	+3	+2	+1	0	-1	-2	-3
11.	Readability with classroom lighting	+3	+2	+1	0	-1	-2	-3
12.	Display self-test	+3	+2	+1	0	-1	-2	-3
13.	Display-failure indication	+3	+2	+1	0	-1	-2	-3
14.	Design of characters (numbers/letters/ symbols)	+3	+2	+1	0	-1	-2	-3
15.	Meaningfulness (understandability) of words, abbreviations, etc.)	+3	+2	+1	0	-1	-2	-3
16.	Feedback information (clear?)	+3	+2	+1	0	-1	-2	-3
17.	Feedback information (enough?)	+3	+2	+1	0	-1	-2	-3
18.	Error feedback (adequate?)	+3	+2	+1	0	-1	-2	-3
19.	Prompts/reminders (enough?)	+3	+2	+1	0	-1	-2	-3
20.	Display reaction time	+3	+2	+1	0	-1	-2	-3
21.	Overall display complexity	+3	+2	+1	0	-1	-2	-3

22.	Overall display design (format, layout) . .	+3	+2	+1	0	-1	-2	-3
23.	Overall display quality	+3	+2	+1	0	-1	-2	-3

Comments on Display Features:

<u>CONTROL KNOB FEATURES</u> (If not applicable to radio, check here [ ] and skip to Item 41.)

24.	Location/arrangement on panel (logical?) . .	+3	+2	+1	0	-1	-2	-3
25.	Accessibility/spacing (uncrowded?)	+3	+2	+1	0	-1	-2	-3
26.	Color contrast (with panel background) . .	+3	+2	+1	0	-1	-2	-3
27.	Knob shape shows which end is the pointer (normal straight-on view)	+3	+2	+1	0	-1	-2	-3
28.	Knob shape shows which end is pointer (from other views)	+3	+2	+1	0	-1	-2	-3
29.	Knob shape helps to identify settings by "feel"	+3	+2	+1	0	-1	-2	-3
30.	Visibility of reference markings on knobs, if any (from normal view)	+3	+2	+1	0	-1	-2	-3
31.	Visibility of reference markings on knobs, if any (from other views)	+3	+2	+1	0	-1	-2	-3
32.	Size (appropriate?)	+3	+2	+1	0	-1	-2	-3
33.	Resistance to damage/wear (sturdiness) . .	+3	+2	+1	0	-1	-2	-3
34.	Force required to move (appropriate resistance?)	+3	+2	+1	0	-1	-2	-3
35.	Range of movement (too large/small?) . . .	+3	+2	+1	0	-1	-2	-3
36.	Knobs stop at end of range	+3	+2	+1	0	-1	-2	-3
37.	Resistance to accidental movement	+3	+2	+1	0	-1	-2	-3
38.	Detents--i.e., "click" stops at settings (too soft/hard?)	+3	+2	+1	0	-1	-2	-3
39.	Appropriate interlocks (stops) to prevent over shooting or accidentally going beyond desired setting	+3	+2	+1	0	-1	-2	-3
40.	Good "feel"	+3	+2	+1	0	-1	-2	-3

Comments on Control Knob Features:

TOGGLE AND/OR BUTTON SWITCH FEATURES (If not applicable to radio, check here [ ] and skip to Item 48.)

41.	Location (convenient?)	+3	+2	+1	0	-1	-2	-3
42.	Size	+3	+2	+1	0	-1	-2	-3
43.	Resistance to damage (sturdiness)	+3	+2	+1	0	-1	-2	-3
44.	Resistance to accidental switching	+3	+2	+1	0	-1	-2	-3
45.	Good "feel" (snap, click)	+3	+2	+1	0	-1	-2	-3
46.	Labels (clear/understandable)	+3	+2	+1	0	-1	-2	-3
47.	Ease of operation	+3	+2	+1	0	-1	-2	-3

Comments on Toggle and/or Button Switch Features:

KEYPAD FEATURES (If not applicable to radio, check here [ ] and skip to Item 58.)

48.	Location of keypad (convenient?)	+3	+2	+1	0	-1	-2	-3
49.	Keys (sturdy? resistant to wear/damage?)	+3	+2	+1	0	-1	-2	-3
50.	Separation between keys (satisfactory for operation without mittens?)	+3	+2	+1	0	-1	-2	-3
51.	Size of keys (adequate?)	+3	+2	+1	0	-1	-2	-3
52.	Surface friction on keys (prevents finger slippage)	+3	+2	+1	0	-1	-2	-3
53.	Feedback (can "feel" when key has been pressed)	+3	+2	+1	0	-1	-2	-3
54.	Good "feel"	+3	+2	+1	0	-1	-2	-3

55. Does the display show something when a key on the keypad is pressed?

a. ____ Almost always, or always
b. ____ Usually
c. ____ About half the time
d. ____ Seldom
e. ____ Almost never, or never

56. Are any of the keys used for anything that is not indicated by a label on the key?

a. ____ None
b. ____ Few
c. ____ About half
d. ____ Most
e. ____ All

57. Does the keypad offer enough features? I.e., will it do enough things required for efficient operation?

a. ____ Definitely yes
b. ____ Probably yes
c. ____ Borderline
d. ____ Probably no
e. ____ Definitely no

Comments on Keypad Features:

FEATURES OF CONNECTOR PLUGS AND SOCKETS

58.	Location	+3	+2	+1	0	-1	-2	-3
59.	Spacing (for easy grasp)	+3	+2	+1	0	-1	-2	-3
60.	Sturdiness (resistance to damage)	+3	+2	+1	0	-1	-2	-3
61.	Coding (dot, arrow, etc., to show proper alignment for insertion)	+3	+2	+1	0	-1	-2	-3
62.	Keying (impossible to put plug in wrong socket)	+3	+2	+1	0	-1	-2	-3
63.	Alignment (can insert plug in socket only one way)	+3	+2	+1	0	-1	-2	-3
64.	Labels (clear identification of connectors)	+3	+2	+1	0	-1	-2	-3
65.	Easy connection/removal (force)	+3	+2	+1	0	-1	-2	-3
66.	Quick connection/removal (one-turn)	+3	+2	+1	0	-1	-2	-3
67.	Dust covers (durability/well-secured)	+3	+2	+1	0	-1	-2	-3

68. Plugs/cables do not obstruct view of front panel . . . . +3 +2 +1 0 -1 -2 -3
69. Plugs/cables do not obstruct operation of controls . . . . +3 +2 +1 0 -1 -2 -3

Comments on Features of Connector Plugs and Sockets:

PROCEDURES (Rate the radio on the ease of accomplishing each of the following procedures. For any procedure listed that is not used by your radio, circle NA--not applicable)

```
[+3] Extremely easy       ---¦
[+2] Very easy            ---¦---¦
[+1] Easy                 ---¦---¦---¦
[ 0] Borderline           ---¦---¦---¦---¦
[-1] Difficult            ---¦---¦---¦---¦---¦
[-2] Very difficult       ---¦---¦---¦---¦---¦---¦
[-3] Extremely difficult  ---¦---¦---¦---¦---¦---¦---¦
                             ¦   ¦   ¦   ¦   ¦   ¦   ¦
                             v   v   v   v   v   v   v
```

70.	Connecting/disconnecting battery	NA	+3	+2	+1	0	-1	-2	-3
71.	Connecting/disconnecting antenna	NA	+3	+2	+1	0	-1	-2	-3
72.	Connecting/disconnecting handset	NA	+3	+2	+1	0	-1	-2	-3
73.	Connecting VINSON	NA	+3	+2	+1	0	-1	-2	-3
74.	Setting VINSON controls	NA	+3	+2	+1	0	-1	-2	-3
75.	Turning on RT	NA	+3	+2	+1	0	-1	-2	-3
76.	Adjusting display brightness	NA	+3	+2	+1	0	-1	-2	-3
77.	Adjusting volume	NA	+3	+2	+1	0	-1	-2	-3
78.	Determining/setting squelch condition .	NA	+3	+2	+1	0	-1	-2	-3
79.	Doing a battery test/check	NA	+3	+2	+1	0	-1	-2	-3
80.	Testing for fault in RT	NA	+3	+2	+1	0	-1	-2	-3
81.	Setting/loading time	NA	+3	+2	+1	0	-1	-2	-3
82.	Loading net ID	NA	+3	+2	+1	0	-1	-2	-3
83.	Loading frequency (non-secure)	NA	+3	+2	+1	0	-1	-2	-3
84.	Establishing net	NA	+3	+2	+1	0	-1	-2	-3
85.	Entering net	NA	+3	+2	+1	0	-1	-2	-3
86.	Synchronizing RT with NCS	NA	+3	+2	+1	0	-1	-2	-3
87.	Obtaining desired display	NA	+3	+2	+1	0	-1	-2	-3
88.	Using handset	NA	+3	+2	+1	0	-1	-2	-3
89.	Loading frequency (secure)	NA	+3	+2	+1	0	-1	-2	-3

90.	Sending ECCM fill	NA	+3	+2	+1	0	-1	-2	-3
91.	Receiving and storing ECCM fill	NA	+3	+2	+1	0	-1	-2	-3
92.	Loading hopset (secure)	NA	+3	+2	+1	0	-1	-2	-3
93.	Responding to cue/page/rescue	NA	+3	+2	+1	0	-1	-2	-3
94.	Late entry into net	NA	+3	+2	+1	0	-1	-2	-3
95.	Re-establishing contact with NCS	NA	+3	+2	+1	0	-1	-2	-3
96.	Carrying RT (manpack)	NA	+3	+2	+1	0	-1	-2	-3

Comments on Procedures:

AUDIO TASKS (Rate the radio on the ease of accomplishing the following tasks. For any task not applicable to your radio, circle NA.

97.	Understanding voice communications (single channel)	NA	+3	+2	+1	0	-1	-2	-3
98.	Understanding voice communications (frequency hopping)	NA	+3	+2	+1	0	-1	-2	-3
99.	Recognizing a tone signal	NA	+3	+2	+1	0	-1	-2	-3
100.	Understanding a tone signal	NA	+3	+2	+1	0	-1	-2	-3
101.	Avoiding static interference	NA	+3	+2	+1	0	-1	-2	-3
102.	Avoiding interference from other stations	NA	+3	+2	+1	0	-1	-2	-3
103.	Controlling volume	NA	+3	+2	+1	0	-1	-2	-3
104.	Recognizing synchronization	NA	+3	+2	+1	0	-1	-2	-3

Comments on Audio Tasks:

VISUAL TASKS (Rate the radio on the ease of accomplishing the following tasks. For any task not applicable to your radio, circle NA.

105.	Controlling brightness	NA	+3	+2	+1	0	-1	-2	-3
106.	Obtaining information from display	NA	+3	+2	+1	0	-1	-2	-3
107.	Understanding display prompts	NA	+3	+2	+1	0	-1	-2	-3
108.	Recognizing a cue/page/rescue	NA	+3	+2	+1	0	-1	-2	-3

109.	Distinguishing between numbers . . .	NA	+3	+2	+1	0	-1	-2	-3
110.	Distinguishing between letters . . .	NA	+3	+2	+1	0	-1	-2	-3
111.	Distinguishing between numbers and letters	NA	+3	+2	+1	0	-1	-2	-3
112.	Recognizing end-of-test (Bit) operation	NA	+3	+2	+1	0	-1	-2	-3

Comments on Visual Tasks:

********* Section 2: Evaluation of Operator Manual (Guide/Handbook) *********

113. Is the print size easy to read?

a. ____ Very easy
b. ____ Easy
c. ____ Borderline
d. ____ Difficult
e. ____ Very difficult

114. The number of illustrations (figures, tables, etc.) was:

a. ____ Way too many
b. ____ Too many
c. ____ About right
d. ____ Too few
e. ____ Way too few

115. Were the illustrations clear?

a. ____ Very clear
b. ____ Clear
c. ____ Borderline
d. ____ Unclear
e. ____ Very unclear

116. The number of pictures in the manual was:

a. ____ Way too many
b. ____ Too many
c. ____ About right
d. ____ Too few
e. ____ Way too few

117. Were the pictures helpful?

a. ____ Almost always, or always
b. ____ Usually
c. ____ About half the time
d. ____ Usually not
e. ____ Almost never, or never

118. Were the illustrations helpful?:

a. ____ Almost always, or always
b. ____ Usually
c. ____ About half the time
d. ____ Usually not
e. ____ Almost never, or never

119. The arrangement/spacing of material on the page was:

a. ____ Very good
b. ____ Good
c. ____ Borderline
d. ____ Poor
e. ____ Very poor

120. The wording of the manual was:

a. ____ Way too difficult
b. ____ Too difficult
c. ____ About right
d. ____ Too easy
e. ____ Way too easy

121. Does the manual cover enough material?

a. ____ Way too much
b. ____ Too much
c. ____ About right
d. ____ Too little
e. ____ Way too little

122. The organization of material (information, sequence of tasks, illustrations, etc.) in the manual was:

a. ____ Very good
b. ____ Good
c. ____ Borderline
d. ____ Poor
e. ____ Very poor

123. Were the summaries (reviews) in the manual helpful?

a. ____ Very
b. ____ Quite
c. ____ Somewhat
d. ____ Slightly
e. ____ Very slightly, or not at all

NA ____ Not applicable

124. As an aid in finding things, was the table of contents helpful?

a. ____ Very
b. ____ Quite
c. ____ Somewhat
d. ____ Slightly
e. ____ Very slightly, or not at all

NA ____ Not applicable

125. As an aid in finding things, was the index helpful?

a. ____ Very
b. ____ Quite
c. ____ Somewhat
d. ____ Slightly
e. ____ Very slightly, or not at all

NA ____ Not applicable

126. Were the sequences of functions needed to properly operate the radio clearly indicated?

a. ____ Almost always, or always
b. ____ Usually
c. ____ About half the time
d. ____ Usually not
e. ____ Almost never, or never

127. Were possible safety hazards or dangers in using the radio well indicated?

a. ____ Very well
b. ____ Well
c. ____ Borderline
d. ____ Poorly
e. ____ Very poorly

128. Was the information on PMCS (Preventive Maintenance, Checks, and Services) clear?

a. ____ Very clear
b. ____ Clear
c. ____ Borderline
d. ____ Unclear
e. ____ Very unclear

129. Was the explanation of individual maintenance clear?

a. ____ Very clear
b. ____ Clear
c. ____ Borderline
d. ____ Unclear
e. ____ Very unclear

130. Overall, how helpful was the manual in learning about the radio.

a. ____ Very
b. ____ Quite
c. ____ Somewhat
d. ____ Slightly
e. ____ Very slightly, or not at all

131. Overall, how would you rate the quality of the operator's manual?

a. ____ Extremely good
b. ____ Very good
c. ____ Good
d. ____ Borderline
e. ____ Poor
f. ____ Very poor
g. ____ Extremely poor

Comments on the Operator's Manual/Guide:

**********************Section 3: Training Evaluation **********************

132. The one-week training period was:

a. ____ Much too long
b. ____ Too long
c. ____ About right
d. ____ Too short
e. ____ Much too short

133. The class instruction was:

a. ____ Very clear
b. ____ Clear
c. ____ Borderline
d. ____ Unclear
e. ____ Very unclear

134. Should the training course be made easier or harder for soldiers who may operate the radio in the future?

a. ____ Much easier
b. ____ Easier
c. ____ No change
d. ____ Harder
e. ____ Much harder

135. The time spent on "hands-on" (practical) exercises was:

a. ____ Much too long
b. ____ Too long
c. ____ About right
d. ____ Too short
e. ____ Much too short

136. The number of "hands on" (practical) exercises was:

a. ____ Way too many
b. ____ Too many
c. ____ About right
d. ____ Too few
e. ____ Much too few

137. The "hands on" (practical) exercises in class were:

a. ____ Very helpful
b. ____ Fairly helpful
c. ____ Borderline
d. ____ Of little help
e. ____ Of very little help

138. The opportunity to ask questions was:

a. ____ Excellent
b. ____ Good
c. ____ Fair
d. ____ Poor
e. ____ Very poor

139. Were answers to students' questions helpful?

a. ____ Almost always, or always
b. ____ Usually
c. ____ About half the time
d. ____ Usually not
e. ____ Almost never, or never

140. The units of instruction were:

a. ____ Much too long
b. ____ Too long
c. ____ About right
d. ____ Too short
e. ____ Much too short

141. The pace of the class (training) was:

a. ____ Much too fast
b. ____ Too fast
c. ____ About right
d. ____ Too slow
e. ____ Much too slow

142. The language level of the instruction was:

a. ____ Much too high
b. ____ Too high
c. ____ About right
d. ____ Too low
e. ____ Much too low

143. The interest level of the course content was:

a. ____ Very interesting
b. ____ Fairly interesting
c. ____ Borderline
d. ____ Fairly boring
e. ____ Very boring

144. The audio-visual aids (overhead slides, pictures, chart boards, etc.) were:

a. ____ Very helpful
b. ____ Fairly helpful
c. ____ Borderline
d. ____ Of little help
e. ____ Of very little help

145. The number of radios used in training was:

a. ____ Very sufficient
b. ____ Sufficient
c. ____ Borderline
d. ____ Insufficient
e. ____ Very insufficient

146. The operator manuals for the radio were used:

a. ____ Very often
b. ____ Often
c. ____ Sometimes
d. ____ Seldom
e. ____ Very seldom, or never

147. The operator manuals used in training were:

a. ____ Very helpful
b. ____ Fairly helpful
c. ____ Borderline
d. ____ Of little help
e. ____ Of very little help

148. The short "in-the-field" exercise you had with the radio was:

a. ____ Very helpful
b. ____ Fairly helpful
c. ____ Borderline
d. ____ Of little help
e. ____ Of very little help

149. Has the training adequately prepared all the students in your class to operate this radio in the field?

a. ____ Definitely yes
b. ____ Probably yes
c. ____ Borderline
d. ____ Probably no
e. ____ Definitely no

150. On an overall basis, rate the radio operator training you received in this class.

a. ____ Extremely good
b. ____ Very good
c. ____ Good
d. ____ Borderline
e. ____ Poor
f. ____ Very poor
g. ____ Extremely poor

Which of the following changes, if any, could be made to improve this training course for future students?

151.	Course length:	____ O.K. as is	____ Increase	____ Decrease
152.	Content level:	____ O.K. as is	____ Raise	____ Lower
153.	Practical exercises:	____ O.K. as is	____ More	____ Fewer
154.	Pace of instruction:	____ O.K. as is	____ Speed up	____ Slow down
155.	Language level:	____ O.K. as is	____ Raise	____ Lower
156.	"Hands on" time:	____ O.K. as is	____ More	____ Less
157.	Audio-visual aids:	____ O.K. as is	____ More	____ Fewer
158.	Reviews:	____ O.K. as is	____ More	____ Fewer
159.	Use of manuals:	____ O.K. as is	____ More	____ Less
160.	Class field exercise:	____ O.K. as is	____ Longer	____ Shorter

Comments on Training:

COMPETITION SENSITIVE INFORMATION (when filled in)

OPERATOR MANUALS EVALUATION FORM

Scale: -100 (Poor), 0 (Fair), +100 (Good)

Area	Radio									
	ERI	HAR	ITT	MAR	RAC	ROC	SEL	TAD	THO	TWC
Content										
Table of Contents										
General Overview										
Operating Instructions										
Maintenance Instructions										
Trouble-shooting										
Specifications										
Subject Index										
Safety Hazards										
Readability										
Type Size										
Paragraph Length										
Spacing										
Sentence Length										
Reading Level										
Margins										
Emphasis										
Illustration										
Number										
Proximity to Discussion										
Clarity										
Picture Quality										
Durability										

COMPETITION SENSITIVE INFORMATION (when filled in)

MP9: OPERATIONAL PROBLEM LOG

Date ______________________________

Name of radio ____________________________

Data Collector ______________________________

Station ID (Call Sign) ___________________

Operator __________________________________

INSTRUCTIONS

1. Use space below to log all problems as they occur.
2. For each problem enter time of occurrence. (If problem occurs several times, enter time for each occurrence. For problems that occur very often or continuously, it may be impossible to enter specific times--if so, indicate in "Problem Description" section below.)
3. For each problem logged, check S, M, or L to indicate whether the problem is "Small, "Moderate," or "Large."
4. Describe the problem in detail.
5. Draw a line under each problem description to separate it from the next description.

PROBLEM LOG

Time	Problem Level S	M	L	Problem Description

[Continue on other side]

PROBLEM LOG, continued

Time	Problem Level S	M	L	Problem Description

[Use additional form if more space is needed]

POST-FIELD-EXERCISE MANPRINT EVALUATION QUESTIONNAIRE

Name: ______________________________ Radio: ________________ Date: ________________

INSTRUCTIONS

- Each question below describes a possible MANPRINT problem.
- If the problem does not apply to your radio (or if you do not understand the question), circle the answer "NA" (not applicable) and skip to the next question.
- If the problem does apply, tell us if your radio had the problem. Circle "Yes" or "No."
- If you circled "No," skip to next question.
- If you circled "Yes," do one of the following:

    1. Estimate how many times the problem happened during your week in the field. Enter a reasonable number--it does not have to be exact. If the problem was continuous, or happened too many times to count write in the letter "C" (for "continuous").

    2. However, if the problem is a "quality" of the radio, circle the letter "Q."

- Then, tell us how important you think it is to fix the problem. Circle 1, 2, or 3, as follows:

1 = Not very important
2 = Fairly important
3 = Very important

	Does not apply	Did your RT have problem?		How many times?		How important to fix?		
SECTION 1: COMMUNICATION PROBLEMS								
001. Static or electronic interference from M113 engine?	NA	Yes	No	[ ]	Q	1	2	3
002. Static or electronic interference from M151 engine?	NA	Yes	No	[ ]	Q	1	2	3
003. Static or electronic interference from M577 engine?	NA	Yes	No	[ ]	Q	1	2	3
004. Static or electronic interference from M60A1 engine?	NA	Yes	No	[ ]	Q	1	2	3
005. Other static problems?	NA	Yes	No	[ ]	Q	1	2	3
006. Bad weather produced poor communications?	NA	Yes	No	[ ]	Q	1	2	3
007. Radio interferes with intercom?	NA	Yes	No	[ ]	Q	1	2	3
008. Background noise made it hard to hear in handset?	NA	Yes	No	[ ]	Q	1	2	3
009. Background noise made it hard to hear speaker?	NA	Yes	No	[ ]	Q	1	2	3
010. Loss of communication using VINSON (KY-57)?	NA	Yes	No	[ ]	Q	1	2	3

011.	Any volume problems when using VINSON (KY-57)?	NA	Yes No	[ ] Q	1 2 3
012.	Static or poor sound quality with VINSON (KY-57)?	NA	Yes No	[ ] Q	1 2 3
013.	Static or poor sound quality with remote hookup?	NA	Yes No	[ ] Q	1 2 3
014.	Problem understanding voice communication in frequency-hopping mode?	NA	Yes No	[ ] Q	1 2 3
015.	Problem understanding voice communication in single (fixed) frequency mode?	NA	Yes No	[ ] Q	1 2 3
016.	Quality of sound is bad (but not due to static)?	NA	Yes No	[ ] Q	1 2 3
017.	Problem sending a CUE call (page/rescue/clear net)?	NA	Yes No	[ ] Q	1 2 3
018.	Failure to hear or see a CUE (page/rescue/clear net)?	NA	Yes No	[ ] Q	1 2 3
019.	Problem with whisper mode?	NA	Yes No	[ ] Q	1 2 3
020.	Accidental or unexplained loss of information loaded into the radio (frequencies, time, etc.)?	NA	Yes No	[ ] Q	1 2 3
021.	Hard to hear or understand communication while wearing MOPP (NBC) gear?	NA	Yes No	[ ] Q	1 2 3
022.	Radio forgets stored information when it is turned off?	NA	Yes No	[ ] Q	1 2 3
023.	Received false CUE (page/rescue/clear net) signals?	NA	Yes No	[ ] Q	1 2 3
024.	Poor voice-transmission quality while frequency hopping?	NA	Yes No	[ ] Q	1 2 3
025.	Poor voice-transmission quality while on a single (fixed) frequency?	NA	Yes No	[ ] Q	1 2 3
026.	Problem sending data in non-secure (clear/plain) mode?	NA	Yes No	[ ] Q	1 2 3
027.	Problem sending data in frequency-hopping mode?	NA	Yes No	[ ] Q	1 2 3
028.	Problem transmitting with power amplifier?	NA	Yes No	[ ] Q	1 2 3

Comments on Communication Problems:

SECTION 2: KEYPAD (KEYBOARD) PROBLEMS

029.	Poor location?	NA	Yes No	[ ] Q	1 2 3
030.	Have to push keys too hard?	NA	Yes No	[ ] Q	1 2 3
031.	Keys push too easily?	NA	Yes No	[ ] Q	1 2 3
032.	Keys sometimes don't work right?	NA	Yes No	[ ] Q	1 2 3
033.	Keys hard to read in low light?	NA	Yes No	[ ] Q	1 2 3
034.	Abbreviations on keys, if any, are hard to understand?	NA	Yes No	[ ] Q	1 2 3
035.	Some keys do things that are not labeled on them?	NA	Yes No	[ ] Q	1 2 3
036.	Keypad too small?	NA	Yes No	[ ] Q	1 2 3
037.	Keys are prone to damage or wear?	NA	Yes No	[ ] Q	1 2 3
038.	Keys too close together for fingers?	NA	Yes No	[ ] Q	1 2 3
039.	Can't feel when key has been pressed?	NA	Yes No	[ ] Q	1 2 3
040.	Keys don't have a good "feel"?	NA	Yes No	[ ] Q	1 2 3

041.	Keys too close together for operation while wearing MOPP (NBC) gloves?	NA	Yes	No	[__]	Q	1	2	3

Comments on Keypad Problems:

SECTION 3: DISPLAY PROBLEMS

042.	Poor location of display window?	NA	Yes	No	[__]	Q	1	2	3
043.	Not bright enough?	NA	Yes	No	[__]	Q	1	2	3
044.	Not dim enough?	NA	Yes	No	[__]	Q	1	2	3
045.	Poor brightness adjustment?	NA	Yes	No	[__]	Q	1	2	3
046.	Bad reflections (glare)?	NA	Yes	No	[__]	Q	1	2	3
047.	Display flickers?	NA	Yes	No	[__]	Q	1	2	3
048.	Poor readability under normal lighting conditions?	NA	Yes	No	[__]	Q	1	2	3
049.	Hard to read display in direct sunlight?	NA	Yes	No	[__]	Q	1	2	3
050.	Hard to read in low light?	NA	Yes	No	[__]	Q	1	2	3
051.	Display difficult to light up?	NA	Yes	No	[__]	Q	1	2	3
052.	Letters and numbers unnecessarily large?	NA	Yes	No	[__]	Q	1	2	3
053.	Letters and numbers too small?	NA	Yes	No	[__]	Q	1	2	3
054.	Display light does not stay on long enough?	NA	Yes	No	[__]	Q	1	2	3
055.	Display light stays on too long?	NA	Yes	No	[__]	Q	1	2	3
056.	Hard to read display from your normal operating position?	NA	Yes	No	[__]	Q	1	2	3
057.	Poor readability from different angles?	NA	Yes	No	[__]	Q	1	2	3
058.	Poor readability from 6-foot distance?	NA	Yes	No	[__]	Q	1	2	3
059.	Numbers or letters on display look strange?	NA	Yes	No	[__]	Q	1	2	3
060.	Some letters and numbers look alike?	NA	Yes	No	[__]	Q	1	2	3
061.	Confuse one letter or number with another?	NA	Yes	No	[__]	Q	1	2	3
062.	Abbreviations used in display not meaningful?	NA	Yes	No	[__]	Q	1	2	3
063.	Capital and small letters mixed together in uncommon way?	NA	Yes	No	[__]	Q	1	2	3
064.	Poor choice of words or symbols used in display?	NA	Yes	No	[__]	Q	1	2	3
065.	Display is too complicated?	NA	Yes	No	[__]	Q	1	2	3
066.	Misread display for any reason?	NA	Yes	No	[__]	Q	1	2	3
067.	Display shows wrong information?	NA	Yes	No	[__]	Q	1	2	3
068.	Display information hard to understand?	NA	Yes	No	[__]	Q	1	2	3
069.	Not enough feedback?	NA	Yes	No	[__]	Q	1	2	3
070.	Not enough reminders?	NA	Yes	No	[__]	Q	1	2	3
071.	Display responds too slowly?	NA	Yes	No	[__]	Q	1	2	3
072.	Display shows nothing when some keys on keypad are pressed?	NA	Yes	No	[__]	Q	1	2	3
073.	Display does not indicate when your input has been accepted?	NA	Yes	No	[__]	Q	1	2	3
074.	Hard to read or see while in MOPP (NBC) gear?	NA	Yes	No	[__]	Q	1	2	3
075.	Display window prone to damage (scratching, etc.)?	NA	Yes	No	[__]	Q	1	2	3

Comments on Display Problems:

SECTION 4: PROBLEMS WITH TOGGLE AND/OR BUTTON SWITCHES

076.	Inconvenient location?	NA	Yes	No	[___]	Q	1	2	3
077.	Too crowded (too close to other controls)?	NA	Yes	No	[___]	Q	1	2	3
078.	Too small?	NA	Yes	No	[___]	Q	1	2	3
079.	Too large?	NA	Yes	No	[___]	Q	1	2	3
080.	Unsturdy (prone to damage)?	NA	Yes	No	[___]	Q	1	2	3
081.	A toggle or button switch broke?	NA	Yes	No	[___]	Q	1	2	3
082.	Easy to switch accidentally?	NA	Yes	No	[___]	Q	1	2	3
083.	Poor "feel" (snap, click)?	NA	Yes	No	[___]	Q	1	2	3
084.	Hard to operate?	NA	Yes	No	[___]	Q	1	2	3
085.	Button or switch hurts finger?	NA	Yes	No	[___]	Q	1	2	3

Comments on Toggle and/or Button Switches:

SECTION 5: PROBLEMS WITH CONTROL KNOBS

086.	Poor arrangement of knobs on front panel?	NA	Yes	No	[___]	Q	1	2	3
087.	Color of controls does not contrast with color of front panel?	NA	Yes	No	[___]	Q	1	2	3
088.	Knobs too crowded (too close to each other or to other controls?)	NA	Yes	No	[___]	Q	1	2	3
089.	Too many knobs or switches needed to perform single function?	NA	Yes	No	[___]	Q	1	2	3
090.	Too large?	NA	Yes	No	[___]	Q	1	2	3
091.	Too small?	NA	Yes	No	[___]	Q	1	2	3
092.	Not shaped right for good grasp?	NA	Yes	No	[___]	Q	1	2	3
093.	Not strong enough?	NA	Yes	No	[___]	Q	1	2	3
094.	A knob broke?	NA	Yes	No	[___]	Q	1	2	3
095.	Did not work right?	NA	Yes	No	[___]	Q	1	2	3
096.	Too hard to turn?	NA	Yes	No	[___]	Q	1	2	3
097.	Too easy to turn?	NA	Yes	No	[___]	Q	1	2	3
098.	Rubber covers easily damaged or prone to wear?	NA	Yes	No	[___]	Q	1	2	3
099.	The range (distance) of movement is too large?	NA	Yes	No	[___]	Q	1	2	3
100.	The range (distance) of movement is too small?	NA	Yes	No	[___]	Q	1	2	3
101.	Hard to see in low light?	NA	Yes	No	[___]	Q	1	2	3
102.	Does not stop at the end of range (easy to overshoot last or first setting)?	NA	Yes	No	[___]	Q	1	2	3

103.	Detents ("click stops" at settings) too soft or too hard?	NA	Yes No	[__] Q	1 2 3
104.	Reference marks hard to see under normal light (from your normal operating position)?	NA	Yes No	[__] Q	1 2 3
105.	Reference marks hard to see from other position?	NA	Yes No	[__] Q	1 2 3
106.	Shape does not show which way knob is pointing?	NA	Yes No	[__] Q	1 2 3
107.	Hard to see where knob is pointing when viewed from side angles?	NA	Yes No	[__] Q	1 2 3
108.	Hard to see where knob is pointing when viewed from above or below?	NA	Yes No	[__] Q	1 2 3
109.	Poor design for turning?	NA	Yes No	[__] Q	1 2 3
110.	Hard to feel where knob is pointing?	NA	Yes No	[__] Q	1 2 3
111.	Accidental movement of knob?	NA	Yes No	[__] Q	1 2 3
112.	Accidentally turn past desired setting?	NA	Yes No	[__] Q	1 2 3
113.	Poor volume control?	NA	Yes No	[__] Q	1 2 3
114.	Poor squelch control?	NA	Yes No	[__] Q	1 2 3
115.	Certain power setting doesn't work right?	NA	Yes No	[__] Q	1 2 3
116.	Control for display light doesn't work well?	NA	Yes No	[__] Q	1 2 3
117.	Hard to use control while in MOPP (NBC) gear?	NA	Yes No	[__] Q	1 2 3
118.	Knob has poor "feel"?	NA	Yes No	[__] Q	1 2 3
119.	Handset push-to-talk doesn't work well?	NA	Yes No	[__] Q	1 2 3
120.	Other handset features don't work well?	NA	Yes No	[__] Q	1 2 3

Comments on Problems with Controls:

SECTION 6: LABEL PROBLEMS

121.	Labels are prone to damage (from rubbing, scratching, or wearing off)?	NA	Yes No	[__] Q	1 2 3
122.	Exact meaning of label unclear, especially to new operator?	NA	Yes No	[__] Q	1 2 3
123.	Poor choice of word or symbol for label?	NA	Yes No	[__] Q	1 2 3
124.	One label is not consistent with another?	NA	Yes No	[__] Q	1 2 3
125.	Label would make more sense if different word or symbol were used?	NA	Yes No	[__] Q	1 2 3
126.	Control is used for things that are not indicated by label?	NA	Yes No	[__] Q	1 2 3
127.	Label indicates something the control will not do?	NA	Yes No	[__] Q	1 2 3
128.	One or more keys on keyboard/keypad are not labeled for everything they do?	NA	Yes No	[__] Q	1 2 3
129.	There are one or more unnecessary labels on the radio?	NA	Yes No	[__] Q	1 2 3
130.	One label can be easily confused with another?	NA	Yes No	[__] Q	1 2 3
131.	Abbreviation in label not meaningful?	NA	Yes No	[__] Q	1 2 3
132.	Can't easily tell which control label refers to?	NA	Yes No	[__] Q	1 2 3

133.	Hard to read important label in low light?	NA	Yes No	[___] Q	1 2 3
134.	Hard to see where control is set because label is poor?	NA	Yes No	[___] Q	1 2 3
135.	Hard to to read label while in MOPP (NBC) gear?	NA	Yes No	[___] Q	1 2 3

Comments on Label Problems:

SECTION 7: PROBLEMS WITH INDICATORS ("BEEPS," TONES, LIGHTS, ETC.)

136.	No indicator to tell when radio is on?	NA	Yes No	[___] Q	1 2 3
137.	Problem with signal strength meter?	NA	Yes No	[___] Q	1 2 3
138.	Problem with sidetone in handset?	NA	Yes No	[___] Q	1 2 3
139.	"Beep" or other tone signal is hard to hear when vehicle engine is running (or with other noise)?	NA	Yes No	[___] Q	1 2 3
140.	Beep or tone is annoying?	NA	Yes No	[___] Q	1 2 3
141.	Beep or tone is not needed?	NA	Yes No	[___] Q	1 2 3
142.	Beep or tone is dangerous because it is too loud?	NA	Yes No	[___] Q	1 2 3
143.	Beep or tone is not loud enough?	NA	Yes No	[___] Q	1 2 3
144.	Meaning of signal is unclear?	NA	Yes No	[___] Q	1 2 3

Comments on Problems with Indicators:

SECTION 8: PROBLEMS WITH CONNECTOR PLUGS, RECEPTACLES, AND CABLES

145.	Receptacles too crowded or too close to other controls?	NA	Yes No	[___] Q	1 2 3
146.	Too many receptacles on front panel?	NA	Yes No	[___] Q	1 2 3
147.	Receptacle is located in inconvenient position?	NA	Yes No	[___] Q	1 2 3
148.	Receptacle has poor or no protective cap?	NA	Yes No	[___] Q	1 2 3
149.	Protective cap is not well attached.	NA	Yes No	[___] Q	1 2 3
150.	Retaining cords or straps on caps get in the way?	NA	Yes No	[___] Q	1 2 3
151.	Cap slips off receptacle too easily?	NA	Yes No	[___] Q	1 2 3
152.	Too hard to get cap off?	NA	Yes No	[___] Q	1 2 3
153.	Receptacle is not sturdy, i.e., can get damaged easily?	NA	Yes No	[___] Q	1 2 3
154.	Part of control can come off and get lost?	NA	Yes No	[___] Q	1 2 3
155.	Screw threads on connector too fine or too course?	NA	Yes No	[___] Q	1 2 3
156.	Hard to connect or remove connector because of lack of space for fingers?	NA	Yes No	[___] Q	1 2 3

157.	Must remove a connector to make room for fingers while inserting a different connector?	NA	Yes No	[__] Q	1 2 3
158.	Hard to line up connector with receptacle because there are no marks (or poor marks) to show the correct position?	NA	Yes No	[__] Q	1 2 3
159.	Can put connector in wrong receptacle?	NA	Yes No	[__] Q	1 2 3
160.	Possible to put connector in right receptacle but wrong position?	NA	Yes No	[__] Q	1 2 3
161.	Label doesn't say that receptacle has more than one purpose?	NA	Yes No	[__] Q	1 2 3
162.	Too much force required to insert or remove connector?	NA	Yes No	[__] Q	1 2 3
163.	Cable does not have quick-connector (one turn)?	NA	Yes No	[__] Q	1 2 3
164.	Cable gets in the way of operating controls?	NA	Yes No	[__] Q	1 2 3
165.	Cable obstructs view of front panel?	NA	Yes No	[__] Q	1 2 3
166.	Cable too long?	NA	Yes No	[__] Q	1 2 3
167.	Cable too short?	NA	Yes No	[__] Q	1 2 3
168.	Cables get tangled up?	NA	Yes No	[__] Q	1 2 3
169.	Cable should be of coiled type, but isn't?	NA	Yes No	[__] Q	1 2 3
170.	Hard to connect antenna to radio?	NA	Yes No	[__] Q	1 2 3
171.	Hard to connect antenna to vehicle?	NA	Yes No	[__] Q	1 2 3
172.	Hard to connect antenna in MOPP (NBC) gear?	NA	Yes No	[__] Q	1 2 3
173.	Poor electrical contact?	NA	Yes No	[__] Q	1 2 3
174.	The radio self-test shows failure but does not tell what part of the radio has failed?	NA	Yes No	[__] Q	1 2 3
175.	Problem connecting VINSON (KY-57)?	NA	Yes No	[__] Q	1 2 3

Comments on Connector Plugs, Receptacles, and Cables:

SECTION 9: PROBLEMS WITH OPERATING PROCEDURES

176.	Problem with PMCS (preventive maintenance, checks, and services)?	NA	Yes No	[__] Q	1 2 3
177.	Troubleshooting problem?	NA	Yes No	[__] Q	1 2 3
178.	Procedure described correctly in manual?	NA	Yes No	[__] Q	1 2 3
179.	Procedure hard to learn?	NA	Yes No	[__] Q	1 2 3
180.	Procedure easy to do wrong?	NA	Yes No	[__] Q	1 2 3
181.	Frequency hopping procedure confusing?	NA	Yes No	[__] Q	1 2 3
182.	Frequency hopping procedure hard to do?	NA	Yes No	[__] Q	1 2 3
183.	Frequency hopping procedure easy to forget?	NA	Yes No	[__] Q	1 2 3
184.	Hard to re-enter net after losing communications?	NA	Yes No	[__] Q	1 2 3
185.	Things happen too fast during any procedure?	NA	Yes No	[__] Q	1 2 3
186.	Procedure is not logical?	NA	Yes No	[__] Q	1 2 3
187.	Wrong procedure might damage the radio?	NA	Yes No	[__] Q	1 2 3
188.	Time or synchronization problem?	NA	Yes No	[__] Q	1 2 3
189.	ERF (electronic remote fill) problem?	NA	Yes No	[__] Q	1 2 3

190.	Problem with CUE (page/rescue/clear net) procedure?	NA	Yes No	[__] Q	1 2 3
191.	Problem loading or setting single frequencies?	NA	Yes No	[__] Q	1 2 3
192.	Problem loading or setting hopset or net ID's?	NA	Yes No	[__] Q	1 2 3
193.	Problem loading any other information into radio?	NA	Yes No	[__] Q	1 2 3
194.	Problem entering or reentering net?	NA	Yes No	[__] Q	1 2 3
195.	Problem establishing a secure net?	NA	Yes No	[__] Q	1 2 3
196.	Problem interfacing with VINSON (KY-57)?	NA	Yes No	[__] Q	1 2 3
197.	Problem interfacing with DMD (digital message device)?	NA	Yes No	[__] Q	1 2 3
198.	Problem interfacing with remote control unit (AN/GRA-39)?	NA	Yes No	[__] Q	1 2 3
199.	Problem interfacing with VFMED?	NA	Yes No	[__] Q	1 2 3
200.	Problem interfacing with BCS?	NA	Yes No	[__] Q	1 2 3
201.	Problem changing from single (fixed) frequency to frequency hopping?	NA	Yes No	[__] Q	1 2 3
202.	Problem with procedure for sending data in secure (cipher) mode?	NA	Yes No	[__] Q	1 2 3
203.	Poor or no battery check available?	NA	Yes No	[__] Q	1 2 3
204.	Poor or no procedure for self-test, or "built-in-test" (BIT)?	NA	Yes No	[__] Q	1 2 3
205.	The self-test sometimes says something is wrong when everything is really okay?	NA	Yes No	[__] Q	1 2 3

Comments on Operating Procedures:

SECTION 10: PROBLEMS WITH MANPACK RADIO

206.	Problem mounting KY-57 (VINSON) on manpack?	NA	Yes No	[__] Q	1 2 3
207.	Manpack straps too short?	NA	Yes No	[__] Q	1 2 3
208.	VINSON on manpack (backpack) causes balance problems?	NA	Yes No	[__] Q	1 2 3
209.	Manpack too heavy?	NA	Yes No	[__] Q	1 2 3
210.	Other problem carrying manpack?	NA	Yes No	[__] Q	1 2 3
211.	No place to carry handset while walking with manpack?	NA	Yes No	[__] Q	1 2 3
212.	Difficulty getting manpack radio to stand up when using it on the ground?	NA	Yes No	[__] Q	1 2 3
213.	Battery installation difficult?	NA	Yes No	[__] Q	1 2 3
214.	Clips on battery case hard to operate?	NA	Yes No	[__] Q	1 2 3
215.	Electrical contacts on battery easy to damage?	NA	Yes No	[__] Q	1 2 3

Comments on Manpack Radio Problems:

SECTION 11: MISCELLANEOUS:

216.	Front panel needs additional lighting at night or in low light conditions?	NA	Yes No	[___] Q	1 2 3
217.	Handles on radio get in the way?	NA	Yes No	[___] Q	1 2 3
218.	Handles are not strong?	NA	Yes No	[___] Q	1 2 3
219.	Required tool for radio was not available to operator?	NA	Yes No	[___] Q	1 2 3
220.	Problem with handset?	NA	Yes No	[___] Q	1 2 3
221.	Received accidental "shock" or "burn" from antenna during transmission or radio self-test?	NA	Yes No	[___] Q	1 2 3
222.	Base of whip antenna too flexible?	NA	Yes No	[___] Q	1 2 3
223.	Base of whip antenna too stiff?	NA	Yes No	[___] Q	1 2 3

Comments on Miscellaneous Problems:

224. Did you take your operator's manual to the field with you?

---- Yes
---- No

225. Did you use your operator's manual in the field?

---- No
---- Yes (About how many times? ______)

226. Was your manual easy to use?

---- Very easy
---- Easy
---- Borderline
---- Hard
---- Very hard

227. Does your manual need revisions?

---- Very few, or none
---- A few
---- Some
---- Many
---- Very many

228. Is your manual durable enough for long-term use in the field?

____ Definitely yes
____ Probably yes
____ Borderline
____ Probably no
____ Definitely no

229. How long should a training class for your radio be?

____ 1/2 day
____ 1 day
____ 2 days
____ 3 days
____ 4 days
____ 5 days or more

230. How much radio operation experience did you have prior to the training you received for this test?

____ A lot (including formal training)
____ Fair amount ("hands-on" experience and/or training)
____ Some (a few hours of experience)
____ A little (a little training, no significant experience)
____ Very little, or none